Entrepreneurial Orientation: An Analysis of Managing Risk

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Abstract

The thesis explores how students, acting as farm managers, mitigate risk by examining and analyzing their risk management decisions on crop choices. The research employs a farm management simulator to examine farming risk mitigation and a survey on demographics and management style to study the students' level of entrepreneurial orientation (EO). The simulation game allows the student-participants to make decisions on crop choices and crop yield insurance. The EO survey on management style endeavors to unveil the reasons behind farm management decisions.

The research specifically seeks to examine farm management decisions on crop choices (crop diversification) and the use of crop yield insurance, and to evaluate the relationship between farm management decisions and the level of EO. The purpose of the thesis is to verify if the level of EO, constructed from the dimensions identified in literature, helps predict farmers' inclination towards crop diversification and crop yield insurance, and eventually their net farm income.

The results of the multivariate panel data regression for four decision periods suggest that crop diversification and crop yield insurance have been adopted as mechanisms to mitigate farming risk. The results as well reveal that the participants' level of EO determines their choice of crops. Participants with a high level of EO score grew higher-risk crops, a result consistent with other empirical studies on entrepreneurship. Besides, participants with high level of EO scores (those who grew higher-risk crops) were more inclined to use crop diversification rather than crop yield insurance. Moreover, the outcome from the panel analysis implies that the level of net farm income depends on the crop portfolio weighted risk index and crop diversification. The greater the crop diversification, the more the net farm income.

The simulation game model mimics the crop choice decision-making activities of real-world farmers. Participants who mitigate risk by employing crop diversification strategies chose higher-risk crops in the simulation game. The study is a step toward developing an analytical basis for future empirical study in farming risk mitigation. Recommendations for future research are developed.

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Dedication

First, I would like to thank my loving Creator for giving me the strength and the opportunity to write this thesis. Second, I dedicate this thesis to my late father, Victor Owusu, for the support he provided me through my entire life. I must also thank my mother, Grace Donkor, and mother in-law, Grace Owusu, for their advice and prayers. I must acknowledge my wife and best friend, Nana-Afia, and my newly born son, Derrick Nimade, without whose love and encouragement, I would not have finished this thesis.

Table of Contents

Permission....................i

Abstract....................ii

Acknowledgements.................... iii

Dedication.................... iii

List of Tables vii

List of Figures.................... viii

Chapter 1. Introduction 9

1.1 Background....................9

1.2 Problem Statement....................11

1.3 Research Questions....................12

1.4 Significance of the Study....................13

1.5 Outline of Thesis Structure 14

Chapter 2. Literature Review and Conceptual Model 15

2.1 Introduction....................15

2.2 Risk Mitigation and Decision-Making in Farming....................16

2.2.1 Entrepreneurial Orientation 18

2.2.2 Relationship between Entrepreneurial Dimensions and Experience 19

2.2.3 Risk Mitigation Strategies: Crop Diversification and Crop Yield Insurance 21

2.3 Conceptual Framework....................22

2.4 Proposed Relationship between Variables....................23

2.4.1 Crop Portfolio Weighted Risk Index (CPWRI) and Proposed Variables....................23

2.4.2 Net Farm Income and Proposed Variables 26

2.5 Chapter Conclusion....................27

Chapter 3. Methodology 28

3.1 Introduction....................28

3.2 Data Collection and Scale Development 28

3.2.1 SaskSim Simulation Game 28

3.2.2 Entrepreneurial Orientation Survey 33

3.3 Theoretical Strategy 33

3.3.1 SaskSim Simulation Game 33

3.3.2 Entrepreneurial Orientation Survey/Questionnaire 40

3.3.3 Econometric Modeling 42

3.4 Justification of Theoretical and Empirical Strategy 45

3.5 Chapter Summary 46

Chapter 4. Data and Preliminary Analysis 47

4.1 Description of the SaskSim Simulation Game Data 47

4.2 Description and Summary of Survey on Management Style 50

4.3 Preliminary Results of Simulation Game and Survey on Management Style 53

4.4 Findings and Discussion 55

4.5 Chapter Conclusion 62

Chapter 5. Conclusion 64

5.1 Review of Research Objectives and Results 64

5.2 Implication 65

5.3 Limitation of Study and Future Research 66

5.4 Chapter Conclusion 67

Reference 68

Appendix 74

Appendix 1: Simulation Game (Bill Brown SaskSim 2015) 74

Appendix 1.1: The Concept of the SaskSim Simulation Game 74

Appendix 1.2: User's Manual for SaskSim 75

Appendix 1.3: Prices and Yields Drawn for Round One and Round Two 77

Appendix 2: Entrepreneurial Survey on Management Style 78

Appendix 2.1: Entrepreneurial Orientation Survey 78

Appendix 2:2: Participant Consent Form 80

Appendix 3: Results – SaskSim Simulation Game..84

Appendix 3.1: Coefficient of Variation 84

Appendix 3.2: Results of the Multivariate Panel Regression Model - CPWRI, CEI, and CYI 85

Appendix 4: Results of Entrepreneurial Orientation Survey on Management Style 90

List of Tables

Table 1: Definition of Independent Variables and their Likely Impact on CPWRI 25
Table 2: Crop Choices 29
Table 3: Means and Standard Deviations of the Crops' Prices and Yields 30
Table 4: Standard Deviations of the Expected Net Income Per Acre.....................................35
Table 5: Explanatory Variables (Survey Responses)...40
Table 6: SaskSim Simulation Game 47
Table 7: Coefficients of Variation of SaskSim Crops 48
Table 8: Net Income Per Acre of Crops Based on their Means of Prices and Yields 48
Table 9: Demographic of the EO Survey...51
Table 10: Results - Survey Questions: Management Style..52
Table 11: Descriptive Statistics of the Variables (Non-Categorical).......................................55
Table 12: Results of Multivariate Panel Regression of Crop Portfolio Weighted Risk Index 56
Table 13: Results of Multivariate Panel Regression of Crop Diversification and Crop Yield Insurance 58
Table 14: Results of Multiple Panel Regression of Net Farm Income 61

List of Figures

Figure 1: Conceptual Model 22
Figure 2: Crop Portfolio Weighted Risk Index (CPWRI) vs. Proposed Variables.................. 24
Figure 3: Percentage of Net Income Per Acre in a Crop Portfolio 49
Figure 4: Relationship between the Averages of CPWRI and EO Score 54

Chapter 1. Introduction

1.1 Background

Risk mitigation in farming is essentially a topic on the agenda of an increasing number of farm businesses around the globe (Coulthard 2007). Farmers that are able to adopt good risk mitigation strategies are more likely to survive in a dynamic environment. Researchers identify crop diversification and crop yield insurance as the traditional risk mitigation strategies that farmers normally use to avoid or minimize risk impacts resulting from price and yield vagaries (a few examples are: Kahan 2013; Nguyen *et al.* 2007; Ojo *et al.* 2014). In addition to the large consensus among researchers on the use of diversification and crop insurance to mitigate risk impacts, the level of entrepreneurial orientation (EO) of farmers influences their risk mitigation strategies. The concept of EO refers to the decision-making processes, managerial philosophies, salient beliefs and behaviours that are entrepreneurial in nature (Lumpkin and Dess 1996; Wiklund and Shepherd 2003; Covin *et al.* 2006; Ferreira *et al.* 2015). Thus, the success of any farm business hinges on the alignment of the complex salient beliefs and decisions of the farmer (Kolvereid and Isaksen 2006).

Previous studies on risk mitigation in farming indicate that decision-making constitutes the fundamentals of the management system of entrepreneurial activity and plays an important role in enhancing farm income (Kahan 2013; Hanson *et al.* 2004; Schillo 2011; Chenuos and Maru 2015). The level of EO influences farmers' decisions on crop choices and crop yield insurance. Generally, while risk-averse farm managers endeavor to mitigate risk in the decision-making process by choosing low-risk crops and high-risk crops with crop insurance, proactively unconventional or risk-loving farm managers usually rely on high-risk crops that guarantee higher gross revenue, making "one size fits all approach" of farming risk mitigation arguably impracticable and even unrealistic (Heifner *et al.* 1999:2-8). The unique nature of farming activities *ipso facto* makes mitigation of risk impacts far more complicated amid a swirl of price and yield vagaries. Therefore, risk mitigation in farm businesses is vitally important and highly complex with an intrinsic host of variables such as price volatility, and unknowability of future crop yields. For example, the 2013 report by the Conference Board of Canada indicates that Canadian farmers face a myriad of managerial problems, which significantly affects their profitability (Stuckey 2013). The report finds a huge gap between farm enterprises in Canada: some farms were below the minimum criteria of being profitable as well as entrepreneurial oriented. Some farm managers outperform others by virtue of their farm management decisions and their level of entrepreneurial orientation. In every practical sense, risk mitigation rests on the decisions of farm managers and the very nature of the farm business.

Regardless of the nature of the farm business, risks affect the achievement of its goals with various contingencies which are inherently unpredictable (e.g. Kimura *et al.* 2010; Hanson *et al.* 2007; Passioura 2006; Koesling *et al.* 2004; Miller *et al.* 2004:4; Sadras *et al.* 2003; Sadras 2002). For example, price volatility risk, crop yield risk, and others related to the environment (such as natural, social, institutional) in which farm businesses operate are a few of the contingencies, which are inherently unpredictable in the agricultural sector. These are intrinsically unique biological factors and characteristics of agriculture, specifically farming. Thus, farm business performance is inextricably linked to the viability of the decisions by virtue of the fact that management is arguably decision-making (Ireland and Miller 2004). Farm managers' risk mitigation decisions and choices have unforeseen repercussions for their farm business financial performance.

Concerning this, research on risk mitigation in farming use data from real world farmers to study their farm management decisions on crop diversification and crop insurance. The current thesis uses a simulation game, which allows the participants to mimic the activities of real world farmers and their risk attitudes are captured through the EO survey. The data obtained from the simulation game and the EO survey are used to study the relationship between the participants' level of EO and their risk mitigation strategies. A key to managing farming risks rests on farm management decisions, which capitalize on new and existing opportunities (Klein 2008). In mitigating risk impacts, farmers normally use financial instruments such as futures and options with the aim of hedging against risk, for instance, lower prices or even make use of low-cost loans, crop diversification, crop yield insurance, forward price contracting, vertical integration, etc. (Kimura *et al.* 2010:25-27; Miller *et al.* 2004:11-20). The level of EO largely influences farm management decisions on crop diversification and crop yield insurance. Hence, farm business financial performance in part rests on how the farmer manages the relationship between his/her level of EO and their decisions on crop choices and crop yield insurance.

The thesis employs a farm management simulator (simulation game) and a survey on EO to analyze farming risk mitigation. The risk mitigation strategies available to the participants in the game include crop diversification and crop yield insurance. The purpose of the research design is to study if there is a strong link between the entrepreneurial oriented participants, crop diversification, crop insurance and net farm income. The simulation game and the EO survey offer an interesting and unique way of analyzing farming risk mitigation.

1.2 Problem Statement

Farming has always been a risky business because of its heavy reliance on nature (Harrison 2007). Farmers' crop choices and their decisions on whether to take crop yield insurance directly influence their farm business financial performance. The risk level of the crops identified in the thesis is determined based on the standard deviations of their expected net returns. A farmer who plants higher-risk crops without crop yield insurance could end up with considerable losses, all things being equal. A farmer may also decide to diversify his/her crop choices: combination of low-risk and high-risk crops. However, higher-risk crops, which in most cases have the potential for higher gross revenue, could contribute tremendously to farm financial performance. Contrary to this popular opinion, lower-risk crops with crop yield insurance could bring unnecessary financial burden on the farm business. This is because farmers will have to pay premiums for the crop yield insurance, which vary depending on the type of crop they grow.

Moreover, most farmers are profit-oriented and profit motives vary from one to another. The farmer who is very ambitious of making large profits may end up taking higher risks, whereas less profit-oriented farmers may rely on crop insurance or choose low-risk crops to at least break-even. It follows that the risk tolerance of the two different farmers described above differs. The approach of the more profit-oriented farmer may be eccentrically different from the less profit-oriented farmer.

Farmers are therefore, engulfed in finding the ultimate risk mitigation strategy pertaining to crop choices (crop diversification) and crop yield insurance. Farm management decisions rest on the farmer's level of entrepreneurial orientation, which determines their approach to risk management. What matters more is how farmers can improve farm management in a way that enables them to sustain their farm business. Good farm management is the key to farm business success (Martin *et al*. 2011; Brodt *et al.* 2006; McElwee 2006). Nevertheless, the farm business decisions and the level of entrepreneurial orientation that constitute good farm management is the problem many farmers face (Kahan 2012). The dilemma raised above is to examine farm management decisions on crop diversification and crop yield insurance of the more entrepreneurial oriented and less entrepreneurial oriented farmers. Most importantly, to determine the risk mitigation strategies adopted by farmers based on their level of entrepreneurial orientation.

1.3 Research Questions

The thesis employs a simulation game and entrepreneurial orientation (EO) survey responses on management style to determine the student-participants' managerial philosophies and other entrepreneurial dimensions such as innovativeness and pro-activeness, risk-taking and competitive aggressiveness that help sustain their farm business financial performance. These dimensions constitute entrepreneurial orientation. The higher the level of these dimensions, the higher the level of entrepreneurial orientation and vice versa. Thus, the thesis scrutinizes the decisions and choices that both high and less innovative, proactive and reactive, risk-averse and risk-loving participants make. The research therefore examines the relationship between the participants' EO scores and their overall risk index associated with their crop portfolio as well as the relationship between the participants' EO scores and the risk mitigation strategies (crop diversification and crop yield insurance). The crop portfolio weighted risk index is the overall risk index for all the crops a participant grows. As such the correlation between the risk mitigation strategies (crop diversification and crop yield insurance) and the crop portfolio weighted risk index is also examined. Another aspect of interest is the link between the participants' net farm income, their crop portfolio weighted risk index and their level of entrepreneurial orientation. The purpose is to establish if the decision to use crop diversification and/or crop yield insurance depends on the level of entrepreneurial orientation, and their eventual effects on net farm income.

In assessing the relationship between the level of entrepreneurial orientation and farm management decisions on crop choices and crop insurance, three important questions arise from this discussion:

Does the level of EO affect crop portfolio weighted risk index?

Does the level of EO affect the participants' inclination to crop choices and/or crop insurance?

What farm management decisions and level of EO enhance net farm income?

In answering these questions above, the research specifically analyzes the relationship between:

crop portfolio weighted risk index and the level of entrepreneurial orientation;
crop diversification and the level of entrepreneurial orientation;

crop yield insurance and the level of entrepreneurial orientation;
crop portfolio weighted risk index and the level of farm experience;
net farm income and crop portfolio weighted risk index;
net farm income and the level of entrepreneurial orientation and;
net farm income, crop diversification and crop yield insurance.

Lastly, the analyses of managing risk require better comprehension of the correlation between crop portfolio weighted risk index and crop diversification as well as crop yield insurance. Therefore, the question that persists is: which participants based on their crop portfolio weighted risk index used crop diversification and/or crop yield insurance as risk mitigation strategies. The study investigates the approaches to farming risk mitigation among the participants with varying levels of entrepreneurial orientation in the simulation game.

1.4 Significance of the Study

The research investigates risk mitigation strategies using a simulation game and EO survey on management style. By employing a farm simulation game to mimic crop choice decisions of farmers in the real world, the study unwraps new directions for a reliable guidance to risk mitigation in farm business management. The research, hence, represents an important contribution to the literature on entrepreneurial orientation and mitigation strategies. The uniqueness of the study rests on the application of a farm simulation game to uncover risk mitigation strategies of farmers respective of their age, sex, and previous farm experience.

The study evaluates whether the participants' managerial philosophies and other entrepreneurial dimensions such as innovativeness and pro-activeness, risk-taking attitudes and competitive aggressiveness, better predict their mitigation strategies. Thus, whether the level of entrepreneurial orientation predicts farmers' decisions on crop diversification and crop yield insurance. Moreover, obtaining data on managerial philosophies and other entrepreneurial dimensions of real-world farmers can be problematic. The approach of the study therefore distinctly offers a better grasp of the activities of the more and less entrepreneurial oriented farmers to complement the existing literature on farming risk management which otherwise could be difficult without a simulation game and survey.

The simulation game and its accompanying EO survey could also be tested using real-world farmers. Concisely, the study contributes to revealing the activities of entrepreneurial oriented farmers in the context of crop diversification and crop yield insurance. This approach, therefore, offers across-the-board insights into the relationship between crop diversification, crop insurance and the level of entrepreneurial orientation.

1.5 Outline of Thesis Structure

The thesis is structured as follows. While the first chapter is dedicated to the background of the thesis, the second chapter considers the literature review and the conceptual model of risk mitigation in farm enterprises. Thus, the second chapter presents a flavor of the related reviews on the premises of entrepreneurial orientation, decision-making, crop diversification and crop yield insurance. Closing the literature section are descriptions of some risk model techniques and advances its conceptual framework that visualizes the proposed relationships between the variables. The framework steers the formulation to guide the empirical strategy and econometric modelling. The aim is to examine the risk mitigation strategies the participants in the simulation game relied on based on their entrepreneurial orientation score. Chapter three outlines the methodology employed in this study. The chapter describes the theoretical and empirical methods used in the simulation game and the entrepreneurial orientation survey on management style. The latter part of the chapter also sketches the empirical strategy employed to analyze the data obtained from the simulation game and the EO survey on management style. Chapter four presents the data and preliminary analysis of the simulation game and the survey responses. The analyses offer insights on the risk mitigation strategies of the participants. Chapter four further canvasses the results and discussion of both the simulation game and survey responses. The concluding chapter outlines the summary of the findings, their implications and future research directions. The thesis attempts to examine risk mitigation in farm business management by comparing and contrasting survey responses to the results of the simulation game.

Chapter 2. Literature Review and Conceptual Model

2.1 Introduction

In spite of the abundant research on EO, there are still no uniform measures for mitigating risk impacts (a few examples are Covin *et al*. 2006; Lumpkin and Dess 1997). This is partly due to the uniqueness of agriculture, which is the basic reason behind the various risk model techniques developed by many economists over the years (a few examples are: Kahan *et al.* 2013:29-86; Nguyen *et al.* 2007; Bryla *et al.* 2004; Miller *et al.* 2004:7-20; Sadras *et al*. 2003; and Heifner *et al.* 1999). Whatever risks farmers are facing in their daily activities, finding ways of mitigating their impacts have been problematic for centuries. Many authors have endeavored to devise several risk mitigation techniques for farm businesses based on the business and political environment, geographical location, amount of invested capital, farm size, type of crops and land quality (Miller *et al.* 2004; Glauber *et al.* 2002; Heifner *et al.* 1999). The present thesis attempts to examine the risk mitigation strategies that farmers use based on their level of entrepreneurial orientation. For example, the circumstance that might pose veritable risks to a farm business in a certain region or country would not be a threat to another farm business in a different region and even in the same province in isolated cases. This very fact complicates the interpretation of research findings on risk management holistically and restricts their generality. Hence, the entrepreneurial proclivity of a farmer could determine their inclination to use crop diversification and/or crop insurance to lessen risk impacts resulting from their decisions and choices. The thesis examines the use of crop diversification and crop insurance as risk mitigation tools in the context of varying levels of entrepreneurial orientation.

Perhaps the difficulties in examining the relationship among the level of entrepreneurial orientation, crop diversification and crop yield insurance could be better explained by the nonlinearity of the profit function (Kahneman and Tversky 1979:283). The existence of uncertainties, for instance, risks associated with future crop yields and prices that creates nonlinearity of the profit function defines farmers' inclination to the use diversification and/or crop insurance. Besides, the cognitive capabilities of farm managers may affect their decisions and choices or their ability to make rational decisions (Deligianni *et al.* 2015; Miller 2007). Kahneman and Tversky (1979:283) further emphasize that the nonlinearity of the profit function in most cases compels decision-makers to rely on "hypothetical" choices while others make choices based on "naturalistic observations of economic behaviour". In a similar vein, most farmers rely on *hypothetical choices* as well as *naturalistic observations of economic behavior* in estimating how a risk might play out over time and carrying out a cost-benefit analysis to decide how best to deal with the emergence of risk. Importantly, the thesis prime focus is to examine how entrepreneurial oriented farmers (with high tendency of risk-taking propensity) mitigate risk impacts.

To examine the mitigation strategies that farmers with varying levels of entrepreneurial orientation rely on to enhance their farm financial performance, it is instructive to consider literature on entrepreneurial orientation and mitigation techniques by many researchers in this field. The chapter, therefore, reviews the contemporary literature on crop diversification, crop insurance and entrepreneurial orientation (including the dimensions of entrepreneurial orientation). Following this is the examination of extant literature on risk mitigation and decision-making in farming. The last section of this chapter advances the conceptual framework.

2.2 Risk Mitigation and Decision-Making in Farming

Risk management pertains to identifying, assessing and prioritizing risks among probabilistic choices with varying degrees of uncertainty in order to direct and apply resources to lessen the chosen choices impact (Hubbard 2009; Antunes and Gonzalez 2015). Risk taking is associated with the willingness to commit large amounts of resources to projects where the cost of failure may be high (Wiklund and Shepherd 2003). Decision-making is therefore the principal activity of risk management (Kahan 2013:11). Kahan (2013:17) refers to risk mitigation as the decisions farmers make to increase their farm business income. The ISO 31000 defined risk as "the effects of uncertainty on objectives (ISO Guide 73 2009)". Hence risk management is a "framework and a process for managing risk (ISO 31000:2009)". Similarly, Hubbard (2009:46) states that risk management is concerned with minimizing, monitoring and controlling the probability and/or the impacts of unfortunate situations. That is, the motive of risk management is to ensure that uncertainty does not swerve the attempt from the goals of the business (Antunes and Gonzalez 2015). Farmers faced a myriad of risks, which are widely researched in the literature (Barnett and Coble 2008).

In the farm business, risks can emerge from different angles, for example, financial risk, marketing risk (including price risk), operational risk, institutional change risk, crop yield risk, and so on (Heifner *et al.* 1999). On a broader perspective, farming risks are much more complex and keep on changing with technological advancement. Farmers from different parts of the world apply different risk mitigation strategies to increase profits or break-even. The decision on the type of risk mitigation strategies to adopt is the most difficult of all (Kahan 2013). To make matters more complex, farmers' level of entrepreneurial orientation influences their decisions and the types of risk mitigation strategies they employ. For example, Rauch *et* *al.* 2009; Dodd and Wang 2011; Freiling and Lütke 2014; and Chenuos and Maru 2015 discuss how the level of EO affects decision-making processes. This very fact compels farmers to devise several risk mitigation strategies that could pervade every stratum of the changing environment (Acikdilli and Ayhan 2013).

Nguyen *et al.*'s (2007) case study on risk management strategies in Australia unveiled that farmers in the region apply risk mitigation techniques such as crop varieties and enterprise diversification, adopting minimum tillage farming practices, minimizing the area of risky crops and maximizing the area of less-risky crops, moisture-conserving farming practices, zero-till planting, investing off-farm, etc. The risk management techniques adopted by these farmers are typical of a country with highly uncertain weather (Nguyen *et al.* 2007). According to Nguyen *et al.* (2007), many of the farmers ranked weather uncertainty as the largest risk, which is generally hard to predict and can be extremely devastating for farm businesses' expected income as it limits the farmers' ability to control crop yields. This may induce large deviations in mean prices of crops, leading to price fluctuations. Bryla *et al.* (2004) explain that farmers in such circumstance, in particular in developing countries and some few advanced countries, have resorted to the use of crop insurance programs to deal with crop yield variations. For example, the Saskatchewan Government has several programs including the Saskatchewan Crop Insurance (SCIC) to support farmers.[1]

The decisions farmers make every day on individual crop choices, combined crop choices or diversification and crop yield insurance affect their farming operations (Kahan 2013:2). Decision-making is therefore an integral part of devising risk mitigation strategies that reflects the entrepreneurial philosophy of the farmer. Besides, farmers' risk attitudes largely shape their decisions on crop diversification and crop yield insurance. Farmers' level of entrepreneurial orientation determines their risk attitudes and therefore, the type of risk mitigation strategies they will adopt: crop diversification or crop yield insurance or both. In spite of the widespread use of several risk mitigation techniques, risk is increasingly prevalent in farming. Many researchers such as Hardaker *et al.* 2004; Reynolds-Allie *et al.* 2013 and others have demonstrated the need for continued research on farming risk mitigation. Perhaps, analyses of risk mitigation based on the level of entrepreneurial orientation using simulated farm data would contribute to the existing literature. Previous studies have explicitly used data from real-world farmers in examining farming risk management (a few examples are: Kahan

[1] For a discussion on this, see: https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/risk-management

2013; Aditto *et al.* 2012; Nguyen *et al.* 2007; and Hanson *et al.* 2004). Nevertheless, accessing data from real-world farmers can be problematic. The decisions and risk mitigation strategies in a simulated farm enterprise would therefore offer a holistic approach to farming risk mitigation and a further discussion on analyzing farmers' crop choice decision.

2.2.1 Entrepreneurial Orientation

Miller (1983) defines the entrepreneurial firm as one that actively takes part in innovative product market, become more proactive compared to their competitors and undertake risks by trying new products or ventures (Taylor 2013). Entrepreneurial orientation involves a firm's inclination to innovate, become more proactive in their decision-making, take risks by trying new ideas in an uncertain environment, and aggressively pursue their goals and eager to seek new opportunities (Rauch *et al.* 2009; Wang 2008; Kropp *et al.* 2008). Farmers' level of entrepreneurial orientation influences their decisions on crop diversification and crop yield insurance. Thus, the degree of risk associated with crops depends on the level of entrepreneurial orientation. Entrepreneurial orientation is therefore an integral component of the determinants of risk and farm performance (Covin and Slevin 1991; Schillo 2011). For instance, Schillo (2011) confirms that several publications as well as a meta-analysis often lead to the conclusion that a higher entrepreneurial orientation is generally associated with risk loving attitudes and increased performance. Miller (1983) originally proposed the term, entrepreneurial orientation, and Covin and Slevin (1989) further developed the concept of entrepreneurial orientation.

Miller (1983) concludes that entrepreneurial orientation consists of three main dimensions: risk taking, pro-activeness, and innovativeness (e.g., Covin and Slevin 1991; Miller 1983; Miller 2007; Miller and Friesen 1978; Venkatraman 1989). Lumpkin and Dess (1996) add two more components (dimensions) to entrepreneurial orientation: autonomy and competitive aggressiveness. Any risk mitigation strategy adopted by farmers reflects their entrepreneurial philosophy on risk-taking, pro-activeness, innovativeness, autonomy and competitive aggressiveness. In other words, the type of mitigation strategies that farmers choose to rely on highly depends on their level of entrepreneurial orientation. Moreno and Casillas (2008) propose that the greater the firm entrepreneurial orientation, the greater will be the degree of launching of new products-technologies. Kreiser and Davis (2010) consider risk-taking, pro-activeness and innovativeness as unique sub-dimensions of entrepreneurial orientation. Kreiser and Davis (2010) further argue that more entrepreneurial oriented firms would exhibit a higher propensity of each sub-dimension of entrepreneurial orientation. The foregoing findings suggest that truly entrepreneurial oriented firms have a high proclivity for risk taking, and thus risk mitigation strategies depend on the farmers' philosophy of effective management.

The case study by Nguyen *et al.* (2007) on Australian farms concludes that farmers typically make decisions based on their managerial philosophies, innovativeness and pro-activeness, risk taking, competitive aggressiveness, etc. For instance, Covin and Miles (1999) posit that scarcely would entrepreneurship exist without innovation. Naldi *et al.* (2007:33) extol the importance of risk taking in entrepreneurial activities and conclude that, "risk taking is a distinct dimension of entrepreneurial orientation". Risk taking is therefore positively associated with pro-activeness and innovation (Naldi *et al*. 2007). Hence, more entrepreneurial oriented farm businesses have a higher tendency of risk taking propensity combined with some degree of pro-activeness, innovativeness and competitive aggressiveness (for example, Covin and Slevin 1991). Therefore, the reliance on crop diversification and/or crop insurance could depend on the level of entrepreneurial orientation of the farmer. In other words, the level of the farmers' entrepreneurial orientation influenced their crop choice decisions and mitigation strategies.

2.2.2 Relationship between Entrepreneurial Dimensions and Experience

Since the primary focus of interest is whether the level of entrepreneurial orientation affects farming risk mitigation, more emphasis has been dedicated to the dimensions of entrepreneurial orientation. As stated earlier, more research has focused on the entrepreneurial dimensions. In elaboration, several researchers made the following conclusions on the relationship among the entrepreneurial dimensions and the hypotheses that were tested in this study. The hypotheses formulation is based on previous studies by Miller 1983; Venkatraman 1989; Lumpkin and Dess 1996; Covin and Slevin 1991; and many more. For instance, reliance on the use of either tried and true products and services or new products and services (including technological leadership and innovation) overall may influence farm business performance. A farm business's readiness to introduce new agricultural practices or become more market-oriented could positively affect its performance (Micheels and Gow 2008). For the risk-loving participants, the changes in the product line could usually be quite dramatic. The results in both scenarios would affect farm financial performance. Specifically, farmers' entrepreneurial philosophy affects their crop portfolio weighted risk index (CPWRI). The crop portfolio weighted risk index (CPWRI) is the overall risks associated with all crops a farmer grows in any given period.

A farmer's previous experience could have a dramatic influence on their crop choices and their level of entrepreneurial orientation. Farming experience plays a key role in decision-making processes and shapes risk attitudes. A more experienced farmer would likely make a better judgement and takes decisions to reduce the impact of an outcome, for all things being equal. The level of managerial experience of a participant, therefore, positively influences their crop portfolio weighted risk index (CPWRI). The crop choices of the participant determine its farm business performance.

A farmer's level of managerial experience will positively influence their crop portfolio weighted risk index (CPWRI).

Extant literature revealed a strong relation between innovation and business performance, in general (Neely and Hii 1998; Lumpkin and Dess 1996:143). Pro-activeness, as Kirzner (1985) puts, is the ability of the entrepreneur to seek out opportunity and capitalize on it. Therefore, participants' ability to seek an opportunity and capitalize on it could translate into higher revenue if carefully executed. These scenarios prove that the level of innovativeness and pro-activeness of participants could go a long way to influence their crop choices. Participants who are neither too pro-active, nor too innovative may be less willing to grow crops with high levels of yield volatility. The level of participant's innovativeness and pro-activeness, therefore, positively affects their average risk index of crop choices.

The level of farm business' innovativeness and pro-activeness will positively influence crop portfolio weighted risk index (CPWRI).

Cooperation, such as establishing business contacts among competing farm businesses, influences business performance. Participants normally adopt either both aggressive/hostile or friendly (live-and-let live attitude) towards their competitors. Thomas *et al.* (2013) concluded that the success of the French wine industry, Domaine de Mourchon could be linked to the winery adoption of more friendly cooperation with other wineries in France and abroad. Therefore, the degree of competitiveness of a participant influences the type of crops the participant grows. A participant with a high level of competitive aggressiveness is more likely to choose high-risk crops with a high level of gross revenue, *ceteris paribus*.

The level of competitive aggressiveness will positively influence crop portfolio weighted risk index (CPWRI).

Decision-making situations involve uncertainty. Participants, who are too optimistic typically, adopt a bold, aggressive attitude in order to maximize the probability of exploiting potential opportunities, whilst less optimistic ones may be cautious to do so. Participants' decisions on investment projects directly affect their revenue. Generally, while some participants favor high-risk investment projects, others are very cautious and prefer low-risk ones with normal and certain rate of returns. Even future optimism may neutralize participants' cognitive dissonance, which could lead them to take bold decisions irrespective of the level of uncertainty (Verhees *et al.* 2010). Thus, if participants are optimistic, they may make bold decisions, which in turn would affect their business performance and vice versa. One could conclude that a risk-loving participant is more likely to choose high-risk crops (total risk).

A higher tendency of risk-taking propensity will positively influence crop portfolio weighted risk index (CPWRI).

2.2.3 Risk Mitigation Strategies: Crop Diversification and Crop Yield Insurance

Crop diversification and crop yield insurance are traditional risk mitigation strategies. Whilst crop insurance is used to manage yield risk, diversification helps to manage both price and yield risks. Nevertheless, farmers' choice of risk mitigation strategy depends on the level of risk associated with the crop(s). Diversification reduces the impact of risk and crop yield insurance limits risk exposure (Reynolds-Allie *et al.* 2013; Kahan 2013:30-47). Crop insurance when taken provides indemnities based on the mean yields of "a suitably wide area" (Anton 2009:24). Several researchers have shown that crop insurance and diversification are risk mitigation tools that farmers rely on amid uncertainty with price and yield (Heifner *et al.* 1999:65-70; Miller *et al*. 2004:12). Crop diversification is a risk mitigation strategy adopted to minimize risk and maximize farm financial performance (Acharya *et al.* 2011; Mandal and Bezbaruah 2013). Diversification limits the effects of crop specialization, and it is an important strategy to minimizing risk impact and maximize resource use.

Research has shown that the level of diversification and crop insurance negatively affect risk associated with yield and price vagaries. Thus, an increased crop diversification lowers risk impact. Likewise, crop yield insurance helps to lessen risk impact. To add more to these conclusions in existing literature, the thesis examines the impacts of crop diversification and crop yield insurance on crop portfolio weighted risk index using the simulated farm data. This offers a more theoretical as well as practical approach to farming mitigation strategies and establishes their relationship with the level of entrepreneurial orientation. The objective is to devise a more holistic approach to risk mitigation strategies in farming.

2.3 Conceptual Framework

An analysis of farming risk mitigation requires a better understanding of the relationship between the simulation game and EO survey on management style. The simulation game is dubbed SaskSim Simulation Game (SSG): is a farm business management simulator that allows the student-participants to make decisions on crop choices, crop yield insurance and crop diversification. The EO survey on management style comprises the items in the entrepreneurial dimensions. The items cover questions on managerial experience, innovativeness and pro-activeness, competitive aggressiveness and risk-taking. The research studies the relationship between the data from the simulation game and the EO survey (see: Figure 1).

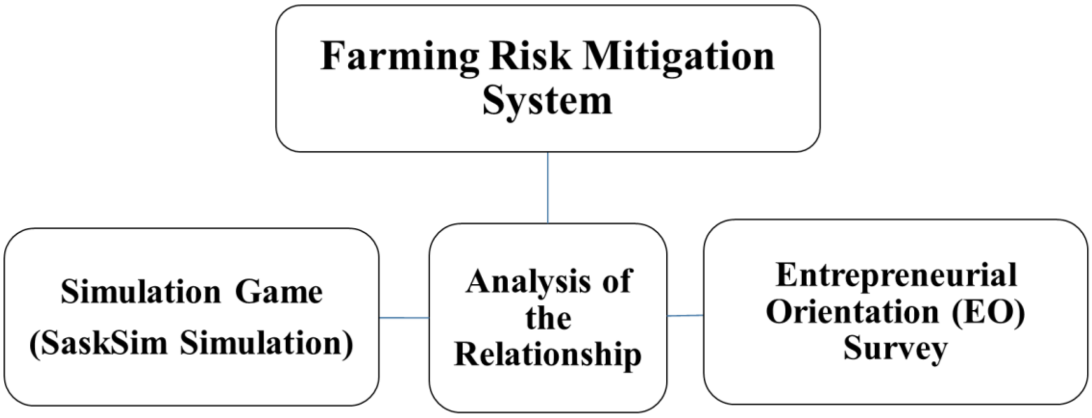


Figure 1: Conceptual Model

The question that persists is: what entrepreneurial orientation dimension influences mitigation decisions and choices? The survey responses are expected to offer explanations to certain decisions taken by the participants in the simulation game (see: Appendix 1 for the description of the game). Another potential question is whether the survey responses help predict the crop choices of the participants or provide clues on how to mitigate farming risks or lessen uncertainty in farm business management.

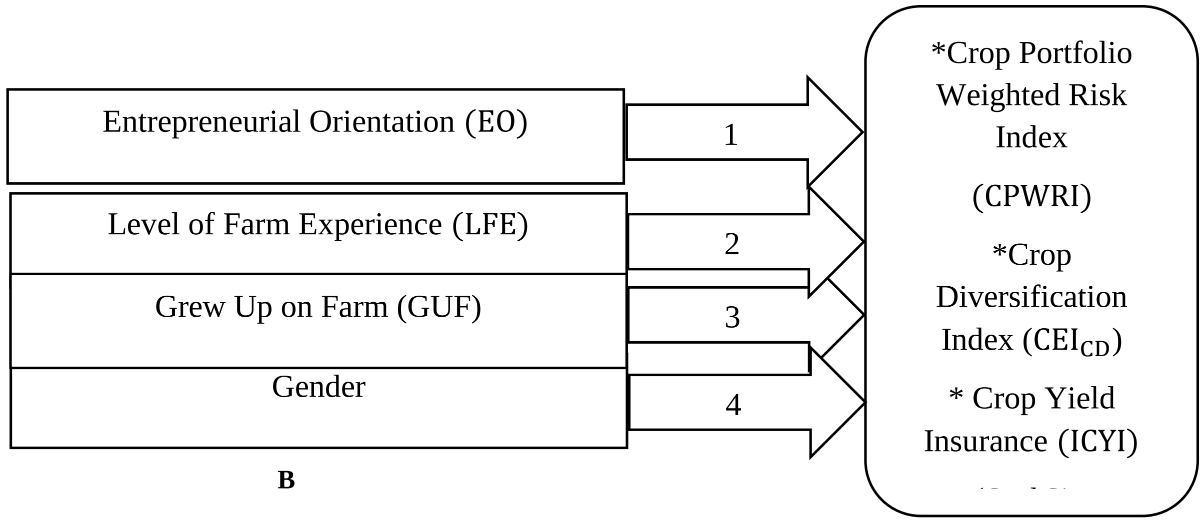
2.4 Proposed Relationship between Variables

2.4.1 Crop Portfolio Weighted Risk Index (CPWRI) and Proposed Variables

In answering the research questions, the items in entrepreneurial orientation dimensions are assumed to influence the participants' crop portfolio weighted risk index (CPWRI). The crop portfolio weighted risk index (CPWRI) measures the level of risk associated with participants' crop choices in any given period of farming. The crop portfolio weighted risk index is measured in terms of the standard deviations of the net income per crop and their acreage proportion in the portfolio. That is, the participant' weighted risk index of crop choices is assessed based on the standard deviation of a portfolio using the number of crops they grow in a given period.

Crop diversification and crop yield insurance are generally expected to minimize crop portfolio weighted risk index. Thus, crop diversification index and crop yield insurance affect the crop portfolio weighted risk index (CPWRI). However, to avoid bias in estimation, dummy variables have been used to categorize the participants into those who took crop insurance and those who did not irrespective of the number of crops insured in any given period. In addition, the level of farm experience (LFE) will positively affect crop portfolio weighted risk index (CPWRI). Other control variables include previous experience (if participants grew up on a farm (GUF)), gender (G), age range (AR) and the participants' class (BPBE 320 or BPBE 322) (C). Participants' program of study was excluded due to its statistically non-significance. The participants' in the BPBE 322 class program of study was agribusiness, whereas those in the BPBE 320 was a mixture of agronomy, environmental science and animal science. Figure 2 shows the relationship between the proposed variables and the independent variables crop diversification index ($\mathrm{CEI}_{\mathrm{CD}}$), crop yield insurance (CYI) and crop portfolio weighted risk index (CPWRI).

A firm's success is increasingly seen as being quite multidimensional (Hart and Milstein 2003). In the same way, a farmer's business performance rests on their decisions on crop diversification, crop yield insurance and at large their level of entrepreneurial orientation. Figure 2 illustrates the endogenous variables in A (*crop portfolio weighted risk index, crop diversification index and index of crop yield insurance*) and the independent variables in B (*entrepreneurial orientation, and the dummy variables*). The study assumed that there is a portfolio weighted risk index. For instance, Thomas *et al.* (2013), using a case study on a French wine company, *Domaine de Mourchon,* conclude that the owner's previous experience helped improve upon business performance tremendously by employing unusual and entrepreneurial marketing. Hence, the participant level of entrepreneurial orientation determines their risk index. Likewise, crop diversification and crop yield insurance determines



Note: *CPWRI is a function of CEI_{CD} and CYI.

Figure 2: Crop Portfolio Weighted Risk Index (CPWRI) *vs*. Proposed Variables

the crop portfolio weighted risk index and therefore, their correlational relationship is considered. The logic behind this assumption is *if A depends on B, then B should help predict A*. Therefore, it suffices to determine how the participants mitigate risk impacts by effectively managing the relationship between *A* and *B*. Based on Figure 2, the study tests the following hypotheses:

Hypothesis 1: The level of entrepreneurial orientation will positively affect crop portfolio weighted risk index.

Hypothesis 2: The level of entrepreneurial orientation will negatively affect crop yield insurance.

Hypothesis 3: The level of entrepreneurial orientation will positively affect crop diversification

Hypothesis 4: The level of farm experience will positively affect crop portfolio weighted risk index.

Hypothesis 5: Crop portfolio weighted risk index will negatively correlate with crop diversification.

Table 1 displays the expected signs of the independent variables in relation to the crop portfolio weighted risk index (CPWRI). The prognostication of the signs of the exogenous variables was established upon the simulated data from the game and the survey using the hypotheses testing

Table 1: Definition of Variables and their Likely Impact on CPWRI

Variables (I)	Definition (II)	Expected sign of Coefficients (III)
Level of Entrepreneurial Orientation (EO)	Entrepreneurial orientation score of a participant	+
Crop Yield Insurance (ICYI)*	= 1 for participant who took crop insurance, 0 otherwise	?
Crop Diversification Index ($\mathbf{CEI_{CD}}$)*	composite index of all the crops a participant grows in a given period	-
Level of Farm Experience (LFE)	Previous managerial experience	+
Gender (G)	= 1 for male, 0 otherwise (female)	?
Age Range (AR)	= 1 for range [18-24], 0 otherwise [25-44]	?
Class (C)	= 1 for BPBE 322 class, 0 otherwise (BPBE 320 class)	?

Note: *Correlational relation with CPWRI. For previous experience (if they grew up on a farm (GUF)) - participants were asked to answer yes if they grew up on a farm, otherwise no.

indicated above. The hypotheses were largely borne out by correlational and multivariate panel regression analysis. Elementary verification shows that the level of entrepreneurial orientation positively affects crop portfolio weighted risk index. Thus, participants with a higher entrepreneurial orientation score would take more risks by selecting mostly a portfolio of higher-risk crops. Likewise, the nature and the level of previous farming experience of the participants should have a positive impact on crop portfolio weighted risk index. That is to say, a more experienced farmer would take more risk to enhance his/her farm financial performance. Participants also use crop yield insurance as a simple strategy to lessen risks.

For this reason, crop yield insurance (CYI) should positively/negatively affect crop portfolio weighted risk index (CPWRI). Besides, the hypotheses testing tries to explore specifically if crop diversification has a role in mitigating risks. Farmers generally rely of crop diversification as a mechanism to cope with risks. The hypothesis testing determines whether there is a negative correlational relationship between the crop diversification index ($\mathrm{CEI_{CD}}$) and the crop portfolio weighted risk index (CPWRI). Finally, in relation to crop portfolio weighted risk index (CPWRI) crop diversification index ($\mathrm{CEI}_{\mathrm{CD}}$) and crop yield insurance (CYI), the categorical variables gender (G), previous experience (GUF), age range (AR) and class of the participants (C) are expected to have a direct or inverse effect on crop choices. The relevance of these control variables cannot be ignored in any empirical study on entrepreneurial orientation.

2.4.2 Net Farm Income and Proposed Variables

The participants' net farm income represents their net cash flow less non-cash costs at the end of each period. Crop diversification and crop insurance go a long way to affect farm business performance (Mandal and Bezbaruah 2013). The benefits of diversification positively affect net farm income. In a similar vein, crop portfolio weight risk index (CPWRI) and the level of EO affect net farm income. This section considers the relationship between net farm income, CPWRI, the crop diversification index and the level of entrepreneurial orientation.

Crop diversification and crop insurance play important roles in enhancing farm income. With the view of reducing risks associated with price and yield vagaries, especially in the absence of crop yield insurance, farmers normally resort to self-insurance by diversifying their crop choices to maximize farm income (Shiyani and Pandya 1998; Mandal and Bezbaruah 2013:170). The expected sign of the crop diversification index and crop yield insurance in relation to the net farm income of the participants is positive. The hypothesis is:

Hypothesis 6: Crop diversification and crop insurance will positively affect net farm income.

In addition, participants with higher entrepreneurial orientation scores are expected to take more risk and therefore earn more income. However, crop diversification and crop yield insurance help lessen risk impacts. Thus, participants' ability to adopt strategies to minimize risk impacts also would certainly increase their net farm income. Mitigating risk impacts should increase net farm income. Thus, the lower the crop portfolio weighted risk index, the higher the net farm income. It can be concluded that:

Hypothesis 7: The level of entrepreneurial orientation will positively affect net farm income.

Hypothesis 8: Crop portfolio weighted risk index will negatively affect farm income.

2.5 Chapter Conclusion

The chapter reviewed previous literature on entrepreneurial orientation, crop diversification and crop yield insurance. In addition, the proposed variables in this thesis were compared with similar empirical studies on risk mitigation. Review of previous research on mitigation strategies and entrepreneurial orientation has shown that the level of entrepreneurial influence farmers' decisions on crop diversification and crop yield insurance. The more entrepreneurial oriented individuals are more likely to take higher risks. Thus, risk taking is a distinct dimension of entrepreneurial orientation. Other factors that affect risks were controlled to avoid estimation bias in the research. Moreover, diversification and crop insurance help mitigate risk impacts and enhance farm income. The hypotheses constructed were based on previous empirical studies and the present study on farming risk mitigation. These hypotheses steer the formulation of the empirical strategy.

Chapter 3. Methodology

3.1 Introduction

The goal of the data analyses and modelling on risk mitigation is to examine the interactions between entrepreneurial orientation, crop diversification and crop insurance in farm business management. The research fundamentally investigates qualitatively and quantitatively the issues raised in the conceptual model. The chapter is organized into five sections with different scope; however, all sections aim to help in investigating farming risk mitigation. Section 3.2 focuses on data collection methods and scale development of the SaskSim Simulation Game (SSG or SaskSim), and the entrepreneurial orientation (EO) survey on management style. Section 3.3 is dedicated to the theoretical and empirical strategy of the thesis. This section employs both qualitative and quantitative methods to explicate the procedures behind the simulation game and the survey outcome. The section also outlines the theoretical analysis and econometric modelling of risk management, and captures the overall heuristic strategy used in assessing and determining the participants' mitigation strategies in the simulation game. Section 3.4 considers the theoretical and empirical justification for the models and captures the overall rationale for using the simulation game and the survey to verify the link between the proposed variables. The last section considers the chapter summary.

3.2 Data Collection and Scale Development

3.2.1 SaskSim Simulation Game

The research employs a simulation game and a questionnaire to collect data. The simulation game, dubbed *SaskSim Simulation Game (SSG)*, is a farm business management simulator that allows participants to make decisions on crop choices and crop insurance based on the information in the SaskSim user's manual (see: Appendix 1.2). The SSG is a spreadsheet program, which allows participants to mimic the activities of farmers in the real world. With this program, participants can grow crops, buy or rent land, decide whether to take crop yield insurance and could farm for a total period of five years. The participants in the simulation game can choose to grow any or all the six crops (see: Table 2). The number of crops a participant can grow depends on the total costs of production and their total cash balance as at the beginning of the farming season. Each participant in the simulation game was assigned an Identification Number (ID) for matching results from SaskSim and the EO survey. At the end of each period, information on each participants' crop choices, crop insurance, funds available, net cash flow, crop revenue and costs of production become available from the farm management simulator (spreadsheet program). The lower the costs of production of a crop, the more of that crop a participant can grow and vice versa. Table 2 displays the list of the crops participants can select to plant:

Table 2: Crop Choices

Crop Code	*Crop Name*
1	Spring Wheat
2	Malt Barley
3	Red Lentils
4	Chickpeas
5	Flax
6	Canola

Source: SaskSim Simulation Game Manual (Bill Brown SaskSim 2015)

The simulation game is run for five periods with each period's decision considered as one year. In other words, period and year are used interchangeably through the thesis. Each participant receives $500,000 cash as a start-up operating capital at the beginning of period one of the farming season. Every participant is allocated four fields (each field of farmland is 640 acres) of farmland at the beginning of the game and they can rent or buy additional land with the funds available to them. There is also the option of credit if the participant decides to buy or rent more farmland for crop planting. A field of farmland can either be purchased at a cost of $640,000 or rented for $32,000. Participants who purchase a field of farmland are supposed to make a down payment of $160,000 and the rest can be borrowed at 4% over 20 years. A yearly principal of $24,000 is required. The participants are students of the University of Saskatchewan from the Department of Bioresource Policy, Business and Economics (BPBE) in 2015.[2] The participants were from BPBE 322 (class one) and BPBE 320 (class two). The simulation game allows the student-participants to choose from the six crops. Based on the means and standard deviations of crop yields and prices, the participants are able to decide whether to insure their crops and pay insurance premiums. The means and standard deviations of the prices and yields of the crops exist for the purpose of conducting the SaskSim Simulation Game rather than actuality. In other words, the estimates for the mean and standard deviation of the prices and yields are not based on historical prices and yields of these crops in the real

[2] The Department has been renamed as Agricultural and Resource Economics (ARE) on February 1st, 2016.

world of farming. The values for the means and standard deviations of the prices and yields enable the participants in the simulation to determine their crop portfolio volatility and expected net income per planted acre. For example, a volatile crop has a high standard deviation. Likewise, a high standard deviation intuitively indicates how much the return on the crop is deviating from the expected normal return. Therefore, the standard deviation is the key basic risk gauge that helps participants in their decisions on crop choices and crop yield insurance (see: Table 3).

Table 3: Means and Standard Deviations of the Crops' Prices and Yields

Items	*Yield*		*Price*	
Crops	Mean	Standard Deviation	Mean	Standard Deviation
Spring Wheat	43 bu/acre	13 bu/acre	\$6.10/bu	\$1.55/bu
Malt Barley	62 bu/acre	27 bu/acre	\$4.50/bu	\$1.15/bu
Red Lentils	1530 lbs/acre	1,000 lbs/acre	\$0.20/lb	\$0.12/lb
Chickpeas	1800 lbs/acre	1,500 lbs/acre	\$.26/lb	\$0.18/lb
Flax	25 bu/acre	12 bu/acre	\$9.40/bu	\$3.65/bu
Canola	36 bu/acre	10 bu/acre	\$9.50/bu	\$2.40/bu

Source: SaskSim Simulation Game Manual (Bill Brown SaskSim 2015)

Participants make their decisions, choices and calculations based on the information in SaskSim Simulation Game manual (Brown SaskSim 2015). Calculations are also generated at the end of each period by entering in the actual prices and yields in their spreadsheets. Prices and yields of the six crops for each decision period are drawn randomly based on their means and standard deviations assuming a normal distribution.[3] Thus, all prices and yields drawn will fall within three standard deviations of their means. However, prices and yields are restricted to one standard deviations below and above and two standard deviations below and above in the simulation game (see: Appendix 1.3 for the prices and yields drawn for both BPBE 322 class and BPBE 320 class). The simulation game uses a random number generator in a spreadsheet to draw prices and yields for each period. For example, in mathematical notation, the price (p) of spring wheat can be expressed as follows, where p is the price from a normally

[3] The determination of prices and yields for each period is based on the empirical rule.

distributed random variable, \$6.10/bu is the mean price of the distribution, and \$1.55/bu is its standard deviation (see: Table (3)), the probabilities (Pr) will be:

$$\Pr(\$6.10 - \$1.55 \le \mathrm{p} \le \$6.10 + \$1.55) \approx 0.6827$$
$$\Pr(\$6.10 - 2 * \$1.55 \le \mathrm{p} \le \$6.10 + 2 * \$1.55) \approx 0.9545$$

Even though prices and yields drawn are supposed to be within two standard deviations below and above, no price or yield is allowed to go to zero in the SaskSim Simulation Game. For example, the mean yield and standard deviation of chickpeas are 1800 lbs/acre and 1500 lbs/acre respectively (see: Table 3). Any yield drawn within two standard deviations has a higher likelihood of falling below zero in the scenario presented below:

$$\Pr(1800\text{ lbs} - 2 * 1500\text{ lbs} \le \text{yield} \le 1800\text{ lbs} + 2 * 1500\text{ lbs}) \approx 0.9545$$
$$\Pr(-1200\text{ lbs} \le \text{yield} \le 4800\text{ lbs}) \approx 0.9545$$

The prices and yields drawn for the period are used to assess the participants' net cash flow per acre and their total cash balance. The total cash balance (TCB) for any given period (t) for each participant (j) is estimated as:

$$\mathrm{TCB_j} = \mathrm{A_t} + \textstyle\sum_{i=1}^{n} \mathrm{NCF_i} \qquad (1)$$

where:

$\mathrm{A_t}$ = beginning cash balance at period (t), which is \$500,000 at period one $(t = 1)$;

$\sum_{i=1}^{n} \mathrm{NCF_i}$ = net cash flow from all the selected crops ($\overline{i, n}$) for a particular period (t).

$$\textstyle\sum_{i=1}^{n} \mathrm{NCF_i} = \sum_{i=1}^{n}[((\mathrm{p_i} * \mathrm{y_i}) - \mathrm{v_i} - \tau_i + (\omega_i * \mathrm{p_i}) * \mathrm{f_i}] \qquad (2)$$

where

$\mathrm{p_i}$ – uncertain market price of crop i;

$\mathrm{y_i}$– uncertain yield of crop i;

$\mathrm{v_i}$– variable costs of production of crop i (includes cash expenses, custom labour, rent, land down payment, land loan principal, and land loan interest);

τ_i − crop insurance premium (if crop yield insurance is taken);

ω_i– benefit from crop yield insurance (if crop insurance indemnity is paid);
and f_i– field of land allocated to crop i (planted acres).

Crop yield insurance, when purchased, guarantees 70% of the mean yield. All six crops are insurable and the insured percentage is determined based on the average yield (see: Appendix (1.2)). Thus, yield guarantee per acre is equal to 70% of the insured crop mean yield if it falls below 70%. For example, using the mean yield and price of red lentils, which is 1530 lbs/acre and $0.20/lb respectively as indicated in Table 3, any yield below 1071 lbs/acre (=0.7*1530 lbs/acre) will trigger indemnity payment. Assuming the mean yield of red lentils dropped by 40% or to 918lbs/acre (=0.6*1530 lbs/acre), this yield will trigger a crop insurance indemnity payment (ω_i). Thus, a participant who took crop yield insurance for red lentils for the period in question will receive:

$$\omega_i = (1071 - 918) * p_i$$
$$\omega_i = 153 \text{ lbs/acre} * \$0.20/\text{lb} = \$30.60 \text{ per acre}$$

where: i is the crop (red lentils) and p_i is the drawn price for the period.

The participants cannot obtain any other form of insurance, apart from the crop yield insurance.

In the SaskSim Simulation Game, participants are faced with uncertain net farm income defined as crop revenue less variable and fixed costs of production plus benefit from a given risk mitigating strategy, in particular, crop yield insurance. In other words, the net farm income is equal to the net cash flow from all the planted crops less non-cash expenses (fixed costs). The formula assumes that buying or renting of farmland does not affect their net farm income. The participants allocate the fields of farmland available to them among a number of crops. The net farm income simulation equation for SaskSim participants is specified in equation (3):

$$\text{NFI}_t = \sum_{i=1}^{n} \text{NCF}_i - \sum_{i=1}^{n} \text{NCE}_i \qquad (3)$$

where:

NFI_t = net farm income at period (t);

NCE_i = non-cash expenses (fixed costs) for a portfolio of (n) crops.

The decisions of the participants are crucial to the continuity of their farming for the next period. The threshold of continuum in the simulation game for the participants is: their total cash balance must be greater than zero (if negative, the affected participants must discontinue farming). The participants' calibration decisions on crop choices and crop yield insurance affect their farm financial performance. The participant level of entrepreneurial orientation plays a significant role in their decision-making processes.

3.2.2 Entrepreneurial Orientation Survey

All the participants in the simulation game were asked to voluntarily complete an online entrepreneurial orientation (EO) questionnaire on demographics and management style to complete (see: Appendix (2) for the details of the questionnaire). Each participant's questionnaire responses are then matched to their results in the SaskSim Simulation Game through their assigned ID. The Assigned Identification Number allows neither the researchers nor the controllers of the experiment to individually identify participants. The ID only allows the researchers to correctly match the data from the simulation game, and the survey for determining the reasons behind the participants' crop choices. Appendix 2 indicates all the items of measurement scales in the survey.

The items on the management style part of the entrepreneurial orientation survey incorporate all the dimensions of entrepreneurial orientation: pro-activeness; competitive aggressiveness; innovativeness; and risk-taking posit by authors such as Miller 1983; Venkatraman 1989; Covin and Slevin 1989; 1991; and Covin and Miles 1999 are few to mention. The questionnaire uses a Likert scale with question seven being on a five-point scale and question eight to fourteen on a seven-point scale similar to the scale adopted by Kropp *et al.* (2008).

3.3 Theoretical Strategy

3.3.1 SaskSim Simulation Game

The choice of crops itself is a risk mitigation tool. Thus, the coefficient of variation indicates the level of risk of the crop resulting price and yield vagaries. However, the standard deviation of the expected net income per acre of a crop better represents the total risk index based on the overall risk impact resulting from price and yield variability. In risk analysis, standard deviations can be used as a proxy for risk (Jaeger 2000; Ortobelli *et al.* 2005). The standard deviation of the expected net income per acre is a measure of how risky it is to grow a particular crop. The higher the standard deviation, the higher the variation in the crop net income. The standard deviation is therefore a measure of how participants' expected net income per acre change based on their crop choices and different prices and yields for a given period. It is noteworthy that, the total risk index of a crop based on the standard deviation of the expected net income per acre is not made available to the participants in the SaskSim Simulation Game. Nevertheless, based on their experiences and managerial ability, the participants make crop selections using the means and standard deviations of the prices and yields of the crops as a guide (see: Appendix 1.2). The standard deviations of the expected net income per are of the crops are used to evaluate the overall crop portfolio weighted risk index of each participant who took part in both the simulation game and the entrepreneurial orientation survey.

The expected net income per acre of the participants' crop choices are estimated based on randomly drawn prices and yields. The expected net income per acre ($\mathrm{NI_{per/acre}}$) based on equation 3 is estimated as:

$$\mathrm{NI_{per/acre}} = \mathrm{NCF_i} - \mathrm{NCE_i} \qquad (4)$$

Crop yield insurance premium is included in estimating the overall expected net income of a participant's crop portfolio if the participant in question took crop yield insurance. The standard deviation of the expected net income per acre of crop is then estimated using a random number generator in the spreadsheet and assuming a normal distribution. Based on the means and standard deviations of the yields and prices indicated in Table 3, the spreadsheet is used to generate randomly a thousand points of prices and yields for all the six crops listed in Table 1. The standard deviation is calculated from the expected net income per acre at each point of price and yield in the spreadsheet. The standard deviation of the expected net income per acre of a crop (σ_i) is used to estimate the crop portfolio weighted risk index. Table 4 displays both the standard deviations of the expected net income per acre without crop yield insurance and with crop yield insurance. In case of the net income per acre with crop yield insurance, crop insurance premium is included at each point of the simulated prices and yields. Indemnity payment is added to gross income (cash inflow) per acre at any point of yield less than 70% of the original mean yield as shown in Table 3.

Among the six crops with varying crop yield standard deviations, participants could choose to plant any combination of crops with/without crop yield insurance. Therefore, the sum of each acreage proportion multiply by their standard deviation of expected net income per acre represents the participant's crop portfolio weighted risk index (CPWRI) in the SaskSim Simulation Game.

Table 4: Standard Deviations of the Expected Net Income Per Acre

Crop	Standard Deviation of Net Income Per Acre (No Crop Yield Insurance)	Standard Deviation of Net Income Per Acre (With Crop Yield Insurance)
Spring Wheat	$ 106.633	$ 98.547
Malt Barley	$ 141.670	$ 125.921
Red Lentils	$ 270.924	$ 254.670
Chickpeas	$ 485.262	$ 464.545
Flax	$ 142.352	$ 131.537
Canola	$ 131.456	$ 125.058

Source: Estimation based on randomly generated prices and yields using the means and standard deviations of the prices and yields in the SaskSim Simulation Game manual (Bill Brown SaskSim 2015).

Crop portfolio is the total collection of all the crops a participant grows for any given decision period. Risk-return of a crop mostly relies on the crop itself. Crop portfolio weighted risk index does not depend only on the individual crops, but also their combination of crops and their degree of correlation. The father of Modern Portfolio Theory (MPT), Markowitz (1952) suggested in his famous article that the variance or the standard deviation of returns can be used as a measure of the risk of a portfolio. Using the standard deviation as a gauge for the amount of expected volatility, the CPWRI can be measured in terms of the standard deviation of the net income per acre of the crops. Applying the formula Markowitz (1952) suggested, the variance of a crop portfolio can be measured as:

$$\sigma^2_{\text{crop portfolio}} = \sum_{i=1}^{n} P_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{l=i+1}^{n} 2 P_i P_l \rho_{i,l} \sigma_i \sigma_l \qquad (5)$$

with $\frac{n(n-1)}{2}$ covariance terms.

where:

P_i = average proportion of the ith crop in the total cropped area, $P_i = {}^{tf * 640}/_{T}$;

tf and T are the number of fields allocated to a crop and total area used for all crops respectively;

σ_i = standard deviation of the expected net income per acre of crop i and;

$\rho_{i,l}$ = correlation coefficient between the net income of crop i and l, where $i \neq l$.

In analyzing the results from the simulation game, it is assumed that there is no correlation among the prices and yields of the crops, and as such the crop pairs have correlations of zero ($\rho_{i,l} = 0$). Since all the crop pairs are perfectly uncorrelated, the variance of the crop portfolio can be rewritten as: $\sigma^2_{\text{crop portfolio}} = \sum_{i=1}^{n} P_i^2 \sigma_i^2$ and the participant' CPWRI for any period (m) is computed using the portfolio standard deviation $\left(\delta_{\text{crop portfolio}}\right)$ expressed as the square root of the variance of the portfolio:

$$\text{CPWRI}_j^t = \sigma_{\text{crop portfolio}} = \sqrt{\sum_{i=1}^{n} P_i^2 \sigma_i^2} = (P_1^2\sigma_1^2 + P_2^2\sigma_2^2 + \dots\dots + P_n^2\sigma_n^2)^{1/2} \qquad (6)$$

where

CPWRI_j^t represents the j-th participant's crop portfolio weighted risk index for period (t), (m=$\overline{1,5}$) and;

i=$\overline{1,n}$ – represents all the crop choices from i to n in any given period (t) – (see: table 1 for the list of crop choices).

The standard deviations of the net income per acre of crops are used to determine the participant's CPWRI for any given period since it represents the overall risk impact of any particular crop choice in the simulation game. For example, assuming two participants (A and B) in the SaskSim Simulation Game made the following decisions on crop choices and crop yield insurance during period two. Their decisions are presented in scenario one. Using the standard deviations of the expected net income per acre of the crops indicated in Table 4, the crop portfolio weighted risk index of the participants can be estimated as shown below.

First, participant A grew three chickpeas and one red lentils, all without crop yield insurance.

Scenario 1: SaskSim Simulation Game – Crop Choice Decision-Making

Participant A		Participant B	
Crops Planted	Crop Yield Insurance	Crops Planted	Crop Yield Insurance
Chickpeas	No	Spring Wheat	No
Chickpeas	No	Malt Barley	No
Chickpeas	No	Flax	Yes
Red Lentils	No	Spring Wheat	No

Participant A crop portfolio weighted risk index can be calculated as:

$$P_{\text{chickpeas}} = {}^{\text{tf} * 640}/_{\text{T}} = {}^{3 * 640}/_{2560} = 0.75; \textit{and}$$

$$P_{\text{red lentils}} = {}^{1 * 640}/_{2560} = 0.25$$

Therefore, Participant A:

$$\begin{aligned} \text{CPWRI}_{\text{A}}^{2} &= (\text{P}_1^2\sigma_1^2 + \text{P}_2^2\sigma_2^2 + \dots\dots + \text{P}_n^2\sigma_n^2)^{1/2} \\ &= (0.75^2 * 485.262^2 + 0.25^2 * 270.924^2)^{1/2} \\ &= 370.195 \end{aligned}$$

Participant B grew two spring wheat, one malt barley and one flax with crop yield insurance. His/her crop portfolio weighted risk index would be:

$$P_{\text{spring wheat}} = {}^{2 * 640}/_{2560} = 0.50;$$

$$P_{\text{malt barley}} = {}^{1 * 640}/_{2560} = 0.25;\ \text{and}$$

$$P_{\text{flax}} = {}^{1 * 640}/_{2560} = 0.25$$

Therefore, Participant B:

$$\mathrm{CPWRI}_{\mathrm{B}}^{2} = (0.50^2 * 106.633^2 + 0.25^2 * 141.670^2 + 0.25^2 * 131.537^2)^{1/2}$$

$$= 71.961$$

The crop portfolio weighted risk index of participant A is higher than that of participant B. Participant A grew a portfolio of high-risk crops whereas B grew a portfolio of low risk crops. Participants could choose to plant one particular crop more than once in the SaskSim Simulation Game, meaning any participant in any given period can select to grow more than four field crops, choosing only one crop or a combination of all six crops available. Thus, a higher CPWRI means a participant grows higher-risk crops and vice versa. The index takes into consideration the acreage of farmland allocated to each crop. The more of a crop a participant grows in the total cropped area the more of its impact on the overall risk index. Diversification may also decrease the CPWRI, especially when high-risk-crops are combined with low-risk crops.

Generally, reduction in risk results from the benefits of diversification. The participants may diversify their portfolio to protect themselves against the risk of a single crop or a specific group of crops. Diversification of crops also is an important strategy to minimize risk impacts. Several empirical studies used different methods to compute crop diversification indices (Shiyani and Pandya 1998; Acharya *et al.* 2011; Pal and Kar 2012; Ojo *et al.* 2014). The indices used in previous empirical studies to measure crop diversification include the Herfindahl Index, the Transformed Herfindahl Index, the Bhatia's Method, the Simpson Index, the Ogive Index, the Entropy Index, the Modified Entropy Index, and the Composite Entropy Index. Considering all the merits and demerits of the indices above as well as their relevance and suitability to the present analysis, the Composite Entropy Index (C.E.I.) appears to be the most appropriate measure of crop diversification in the simulation game. Thus, the Composite Entropy Index (C.E.I.) helps to estimate more accurately the crop diversification index for any combination of crops. The Composite Entropy Index for crop diversification of the jth participant, indicated by - $\mathrm{CEI}_{\mathrm{CDj}}$, has been computed using the following formula (see: Equation (7)).

$$\mathrm{CEI}_{\mathrm{CDj}} = -\left[\sum_{i=1}^{n} \mathrm{P_i} \log_n \mathrm{P_i}\right]\left[1 - \left(\frac{1}{\mathrm{N}}\right)\right] \qquad (7)$$

Where, P_i represents the acreage share of the ith crop in total cropped area, and N represents the total number of crops grown in a given period. The index factors in the proportion of each crop in the total cropped farmland and the number of crops planted. The index rises with an increase in crop diversification. The reverse is true in all cases and the values range from one to zero. Zero values mean participants grow only one crop, indicating crop specialization, whereas any value greater than zero indicates crop diversification. Hence, the higher the index, the higher the level of diversification. For instance, using scenario one, participant A would have crop diversification index of:

$$\mathrm{CEI}_{\mathrm{CDA}} = -\left[\sum_{i=1}^{4} \mathrm{P_i} \log_4 \mathrm{P_i}\right]\left[1 - \left(\frac{1}{4}\right)\right]$$

$$= -[0.75 * \log_4(0.75) + 0.25 * \log_4(0.25)]\left[1 - \frac{1}{4}\right]$$

$$= 0.304$$

And the crop diversification index for participant B would be:

$$\mathrm{CEI}_{\mathrm{CDB}} = -\left[\sum_{i=1}^{4} \mathrm{P_i} \log_n \mathrm{P_i}\right]\left[1 - \left(\frac{1}{\mathrm{N}}\right)\right]$$

$$= -[0.50 * \log_4(0.50) + 0.25 * \log_4(0.25) + 0.25 * \log_4(0.25)]\left[1 - \frac{1}{4}\right]$$

$$= 0.563$$

The crop diversification index for participant B is higher than that of participant A. Participant B diversified his/her crop portfolio by allocating two fields of land to spring wheat, one field to malt barley and one field to flax, whereas participant B allocated three fields of land to chickpeas and one field to red lentils. Assuming, for instance, participant B decided to grow chickpeas on all his/her four fields of land, crop diversification index would be zero as indicated below:

$$\mathrm{CEI}_{\mathrm{CDA}} = -[1 * log_4(1)]\left[1 - \left(\frac{1}{4}\right)\right] = -[1 * 0][1 - 0.25] = -[0 * 0.75] = 0$$

Therefore, the higher the diversification, the higher the index. Crop specialization would have diversification index of zero, whereas growing more than one different crop would have diversification index greater than zero.

3.3.2 Entrepreneurial Orientation Survey/Questionnaire

The decisions of the participants in any given period depend on their risk attitudes. The study therefore, tests the explanatory variables (survey responses) on the results from the SaskSim Simulation Game (see: Table 5).

Table 5: Explanatory Variables (Survey Responses)

Level of Farm Experience	Innovativeness and Pro-activeness	Competitive Aggressiveness	Risk-taking
LFE	IP	CA	RT
Question 7	Question 8-9	Question 10-11	Question 12-14

The idea behind this is to determine whether there is a correlation between crop choices and participants' level of entrepreneurial orientation. The level of entrepreneurial orientation of the participants in the simulation game is measured based on the exogenous variables. Similarly, the average risk index of crop choices of each participant is measured based on their crop choices for the period. The purpose is to match the participant's level of entrepreneurial orientation to their crop risk level and determine if the former helps predict the latter. For instance, participants who score high on the EO are believed to be more innovative and pro-active, competitively aggressive and less risk averse (Rezaei *et al.* 2012; Covin and Slevin 1989).

Rezaei *et al.* (2012:4064) conceptualize that firms with "…high score on EO are believed to be engaged in innovation frequently, to be more willing to take risks and to act more proactively when opportunities arise." In a similar vein, Covin and Slevin (1989) emphasize that entrepreneurial firms are characterized by their innovative, pro-active, aggressive and risk-taking management style. On the contrary, conservative firms are less innovative and reluctant to engage growing high risky crops. In determining the level of entrepreneurial or conservative orientation of firms, Covin and Slevin (1989) employ three items for each entrepreneurial dimension to measure the level of entrepreneurship of firms. The study, hence, considers innovativeness, risk-taking, competitive aggressiveness and pro-activeness as important dimensions of the concept of entrepreneurial orientation (Miller 1983; Covin and Slevin 1989; Rezaei *et al.* 2012). The research also uses the models suggested by Covin and Slevin 1983; Miller 1983 and the methods employed by Rezaei *et al.* 2012 with modifications to measure the level of entrepreneurial orientation of each participant in the simulation game. Rezaei *et al.* (2012), in their work adopted four different methodologies in measuring the construct of entrepreneurial orientation: a naïve methodology, the traditional statistical methodology, a DEA-like methodology, and a fuzzy-logic methodology. Considering the advantages and drawbacks of each methodology as well as the nature of the simulation game, which mimics a real-world case, it is expedient to employ the naïve methodology in measuring the level of each participant.

The naïve methodology uses an average of the item scores on each entrepreneurial dimension as a measure of the level of entrepreneurial orientation, and "is used in most real-world cases" (Rezaei *et al.* 2012:4065). Drawing on a sample of 67 participants in an administered questionnaire in the SaskSim Simulation Game, the measurement of the level of entrepreneurial orientation is based on participants' innovativeness and pro-activeness, competitive aggressiveness, and risk-taking. The sample size varies depending on the test, as some participants did not fully complete the EO survey on management style. Using the naïve methodology adopted by Rezaei *et al.* 2012 with modifications, the participants' level of entrepreneurship is computed as:

$$\text{EO Score} = \frac{1}{7}[\,\text{IP8} + \text{IP9} + \text{CA10} + \text{CA11} + \text{RT12} + \text{RT13} + \text{RT14}] \qquad (8)$$

where

EO Score – participant's score on the EO;

1P - variable for innovativeness and pro-activeness (eight and nine represent the items/questions);

CA - variable for competitive aggressiveness (ten and eleven represent the items/questions); and

RT - variable for risk-taking (twelve, thirteen and fourteen represent the items/questions).

A high score on the EO is believed to represent a high level of entrepreneurial posture and vice versa.

3.3.3 Econometric Modeling

This section formulates a model that predicts crop choice by studying the relationship between the results of the SaskSim Simulation Game and the entrepreneurial orientation survey on management style. Specifically, the econometric modelling in this section seeks to analyse the relationship between the dependent variables, crop portfolio weighted risk index (CPWRI), crop diversification index ($\mathrm{CEI_{CD}}$) and crop yield insurance (CYI), and the following independent variables:

- the level of entrepreneurial orientation (including EO dimensions: innovativeness and proactiveness (IP); competitive aggressiveness (CA) and risk-taking (RT) and;
- level of farm experience (LFE).

The model also includes categorical variables such as previous experience (GUF - if participants grew up on a farm), age range (AR), gender (G), and class group of a participant (C). Several methods were employed to compute the index of crop yield insurance, however, the use of dummy yielded significant results in the model.

In assessing the relationship between crop portfolio weighted risk index and the level of entrepreneurial orientation as well as crop diversification index more rigorously, it is necessary to control these variables as stated earlier in this thesis. The following dummies were created for crop yield insurance, previous experience, gender, and age range:

$$\text{Crop Yield Insurance (CYI)} = \begin{cases} 1, \text{if the participant took crop insurance} \\ 0, \text{if the participant took no crop insurance} \end{cases}$$

$$\text{If participant grew up on a farm (GUF)} = \begin{cases} 1, \text{if the participant grew up on a farm} \\ 0, \text{if the participant did not grow up on a farm} \end{cases}$$

$$\text{Gender (G)} = \begin{cases} 1, \text{if the participant is male} \\ 0, \text{if the participant is female} \end{cases}$$

$$\text{Age Range (AR)} = \begin{cases} 1, \text{if the participant is within the range } [18-24] \\ 0, \text{if the participant is within the range } [25-44] \end{cases}$$

All the prices and yields, except for period one, which used the mean yield and price, were different for each class over the entire period of farming. As the observations came from two different classes, class dummies are necessary to account for the prices and yields difference. This could affect participants' choice of crops and hence their overall risk index. Therefore, taking BPBE 320 as a reference category, one dummy variable was created, outlined as C.

$$\text{Class (C)} = \begin{cases} 1, \text{if the participant is in BPBE 322} \\ 0, \text{if the participant is in BPBE 320} \end{cases}$$

To determine the relationship between the dependent variables, crop portfolio weighted risk index (CPWRI), crop diversification index ($\mathrm{CEI_{CD}}$) and crop yield insurance (CYI), and the independent variables, the multivariate panel regression model has been used to account for cross-sectional and time series nature of the data. Incorporating the exogenous variables (including categorical variables) defined above, $\mathrm{CPWRI_j}$, $\mathrm{CEI_{CDj}}$ and $\mathrm{CYI_j}$ have been formulated as shown by equations (9.1), (9.2) and (9.3) respectively.

$$\mathrm{CPWRI_j^t} = \tau_1 + \tau_2\mathrm{EO_j} + \tau_3\mathrm{GUF_j} + \tau_4\mathrm{G_j} + \tau_5\mathrm{AR_j} + \tau_6\mathrm{C_j} + \varepsilon_{jt} \qquad (9.1)$$

$$\mathrm{CEI_{CDj}^t} = \tau_1 + \tau_2\mathrm{EO_j} + \tau_3\mathrm{GUF_j} + \tau_4\mathrm{G_j} + \tau_5\mathrm{AR_j} + \tau_6\mathrm{C_j} + \varepsilon_{jt} \qquad (9.2)$$

$$\mathrm{CYI_j^t} = \tau_1 + \tau_2\mathrm{EO_j} + \tau_3\mathrm{GUF_j} + \tau_4\mathrm{G_j} + \tau_5\mathrm{AR_j} + \tau_6\mathrm{C_j} + \varepsilon_{jt} \qquad (9.3)$$ [4]

[4] The estimation used logit model on the panel data.

where

CPWRI_j^t= crop portfolio weighted risk index for jth participant at period(t),

CEI_{CDj}^t= crop diversification index for jth participant at period(t),

CYI_j^t = crop yield insurance for jth participant at period(t),

EO_j= level of entrepreneurial orientation for jth participant,

GUF_j = previous experience for jth participant,

G_j = 1 if the gender is male, 0 if not,

AR_j = 1 if the age is within the range [18 – 24], 0 if not [25-44],

C_j = 1 if the participant is in BPBE 320, 0 if not (BPBE 322).

The equations were estimated using the ordinary least squares method assuming that error term ε_{jt} are independently normally distributed with zero mean. Equation (9.1) was also tested by replacing the participants' EO scores with the scores on each item in the entrepreneurial dimensions. They include innovativeness and proactiveness (IP), competitive aggressiveness (CA) and risk-taking (RT). Also, since a strong link between EO, level of farm experience and crop portfolio weighted risk index is expected, equation (9.1) is again tested by incorporating the level of farm experience (LFE). The coefficients of the results are reported in this thesis, irrespective of their statistical significance.

The impacts of crop portfolio weighted risk index, crop diversification and crop yield insurance on net farm income have been explored using the multiple panel regression model. Crop diversification could improve farm income and crop yield insurance could cover losses beyond farmers' control. Besides, the level of entrepreneurial orientation is expected to influence the level of net farm income. The model is specified in equations (10.1) and (10.2).

$$\mathrm{Log}(\mathrm{NFI}_{jt}) = \gamma_1 + \gamma_2\mathrm{EO}_j + \gamma_3\mathrm{CPWRI}_{jt} + \epsilon_{jt} \qquad (10.1)$$

$$\mathrm{Log}(\mathrm{NFI}_{jt}) = \gamma_1 + \gamma_2\mathrm{EO}_j + \gamma_3\mathrm{CEI}_{CDjt} + \gamma_4\mathrm{CYI} + \epsilon_{jt} \qquad (10.2)$$

where, $\mathrm{Log}(\mathrm{NFI}_{\mathrm{jt}})$ is the logarithm of net farm income, EO_{j} is the level of entrepreneurial orientation, $\mathrm{CPWRI}_{\mathrm{jt}}$ is crop portfolio weighted risk index, $\mathrm{CYI}_{\mathrm{jt}}$ is the crop yield insurance for jth participant at period(t), and $\mathrm{CEI}_{\mathrm{CDjt}}$ is the crop diversification index for jth participant at period (t).

3.4 Justification of Theoretical and Empirical Strategy

The statistical methodologies employed in the study provide advanced tools for future research in farming risk mitigation. The SaskSim Simulation Game makes it possible to examine some of the risk mitigation strategies of farm managers. Previous studies have explicitly used data from real-world farmers to analyze farming risk mitigation strategies (a few examples are: Kahan 2013; Aditto *et al.* 2012; Nguyen *et al.* 2007; and Hanson *et al.* 2004). Nevertheless, accessing data from real world farmers can be problematic. As such, even if these data were easily accessible, their completeness and accuracy become a different issue that researchers would have to deal with. Despite the recent rise of academic interest in farming risk mitigation, the field still struggles to establish a standard body of risk mitigation strategies due to the inaccessibility and insufficiency of information from farmers. The SaskSim Simulation Game, therefore, makes it easier to gather data on farming risk mitigation strategies.

In spite of the uniqueness of the farm management simulator, the game follows a strategical pattern and employs basic statistical methods, which are in congruence with risk mitigation in the real world of farming. The game allows participants, acting as real farmers, to make decisions on what type of crop(s) to grow for a given period. The option of crop insurance and crop diversification constitutes an essential part of the decision-making process. The SaskSim spreadsheet program also includes prices and yields draw for every period. The price and yield draw depend on the means and the standard deviations of the crops prices and yields.

The entrepreneurial orientation survey on management style used both five-item and seven-item formulation. The research converts the original semantic differential statements response format employed by pioneers of entrepreneurial orientation, such as Covin and Slevin 1989 and Millers 1983, to Likert-scales. The format of the questionnaire follows a similar pattern of those used in measuring the level of entrepreneurship. That is, the methodological approach offers a new uncomplicated way to analyze farming risk mitigation.

Lastly, to assess the relationship between the proposed variables, several econometric models were tested including the mixed logit regression and conditional logit regression. In other words, the multivariate panel regression appears to be the most suitable model for the data. The SaskSim Simulation Game was run for a period of five years. In total sixty-seven participants took part in both the game and the entrepreneurial orientation survey. Although, time series were not observed in the survey, the multivariate panel analysis captures the cross-sectional and time series nature of the data.

3.5 Chapter Summary

The academic interest in farming risk mitigation strategy in every practical sense has increased in recent years. Perhaps, there is little consensus on what constitutes a genuine approach to analyze farming risk mitigation. The chapter outlined the thesis methodological approach to analyzing farming risk mitigation. It identified the SaskSim Simulation Game (SSG) as a new way of studying the decisions and crop choices of farmers without having to contact farmers in the real world. The entrepreneurial orientation survey, on the other hand, provides the opportunity to investigate some of the reasons behind the decisions on crop choices of the participants.

The multivariate panel model is used to analyze the relationships between the dependent variables, crop portfolio weighted risk index, crop diversification and crop yield insurance and the independent variables. The independent variables include the level of entrepreneurial orientation, managerial experience, gender, age range and class of participants. Besides, multiple panel regression model is also used to examine the relationship between farm income, crop portfolio weighted risk index, crop diversification, crop yield insurance and the level of entrepreneurial orientation.

The methodological model as a whole is feasible and in conformity with other statistical approaches to analyzing farming risk mitigation. The following chapter presents the preliminary analysis of the results from the simulation game and the survey on management style.

Chapter 4. Data and Preliminary Analysis

4.1 Description of the SaskSim Simulation Game Data

The SaskSim Simulation Game consists of two classes. The participants who participated in simulation game were students of the Department of Bioresource Policy, Business and Economics (BPBE) at the University of Saskatchewan during the year of 2015. Table 6 displays the number of participants that took part in the simulation game for each period.

Table 6: SaskSim Simulation Game

Item	**Class 1: BPBE 322**	**Class 2: BPBE 320**	**Class 1 & 2**
Year	No. of Students	No. of Students	Total
1	29	38	67
2	26	35	61
3	24	36[P]	60
4	11	35	46
5	9	26	35

Note:[P] A participant rejoined the simulation game, although they did not take part in the previous period.

Specifically, students from the BPBE 322 class and BPBE 320 class participated in the simulation. The two classes represent agribusiness majors and primarily agronomy majors respectively. The simulation game was run for five periods with each decision period considered as a farming year. The participants in BPBE 322 (class one) began with twenty-nine and ended with nine students. The participants in the second class (BPBE 320) also began with thirty-eight and ends with twenty-six participants. The simulation game rules were the same for each class. A participant is removed from the game if his/her total cash balance falls below zero. Moreover, participants could drop out of the game due to voluntary game exit. In all, sixty-seven students took part in the simulation game during period one and thirty-five participants were able to complete the simulation game.

The decisions on crop choices, crop yield insurance and diversification were crucial to participants' financial performance in the simulation game. Crop yield risk and price fluctuations significantly vary across the six crops and between the two classes. Table 7 reports the coefficients of variation of the crops yield and price.

Table 7: Coefficients of Variation of SaskSim Crops

Crop	Coefficients of Variation	
	Yield	Price
Spring Wheat	0.302	0.254
Malt Barley	0.435	0.256
Red Lentils	0.654	0.600
Chickpeas	0.833	0.692
Flax	0.480	0.388
Canola	0.278	0.253

Source: Estimation based on the means and the standard deviations of the prices and yields in the SaskSim manual.

The coefficient of variation (CV) for canola, for instance, indicates that the standard deviation of the crop yield and price is approximately 28% and 25% respectively of their means, which is the lowest among all. In a similar vein, the coefficient of variation (CV) for chickpeas show

Table 8: Net Income Per Acre of Crops Based on their Means of Prices and Yields

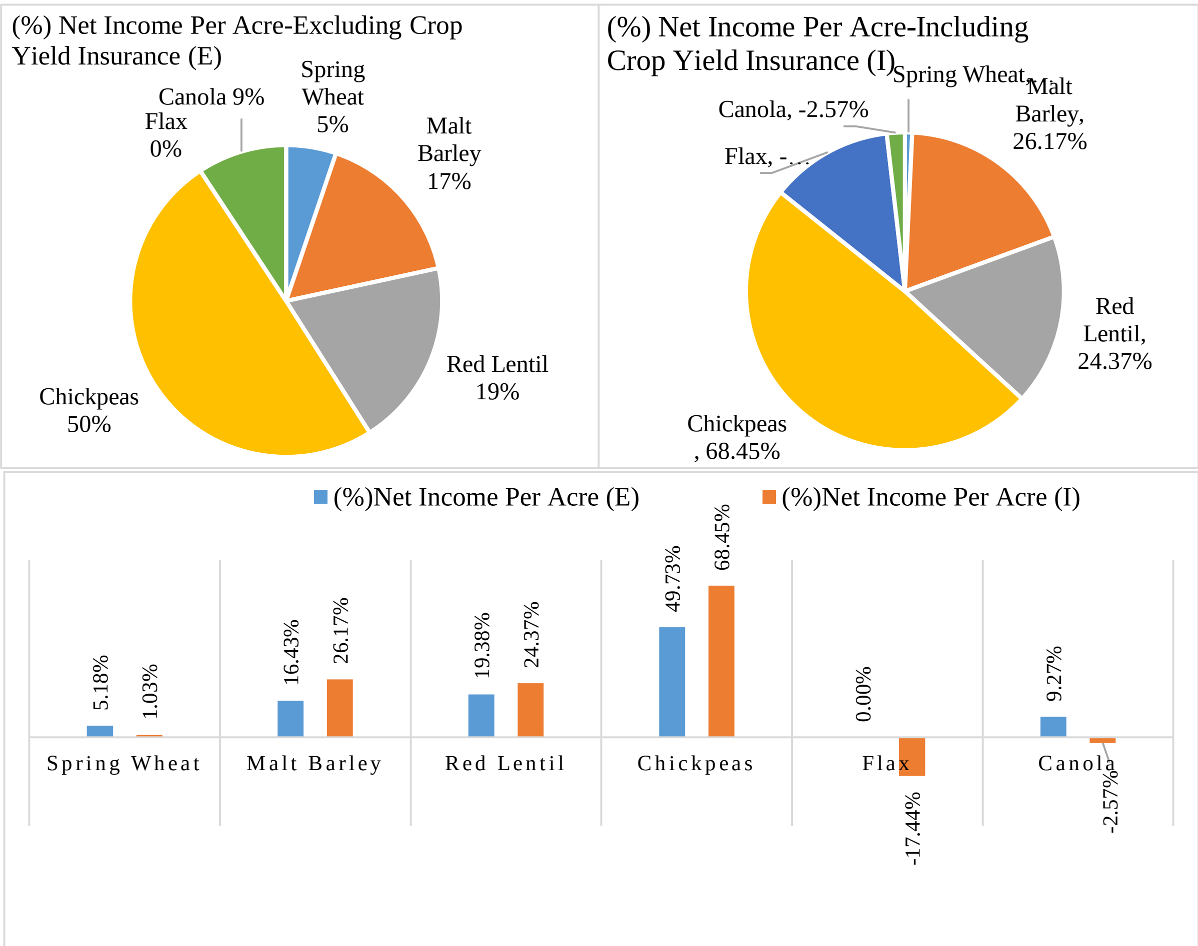
Estimation Based on Mean Yield and Price						
Crop Type	Spring Wheat	Malt Barley	Red Lentils	Chickpeas	Flax	Canola
Yield (bu/acre, *lbs/acre)	43.00	62.00	*1530.00	*1800.00	25.00	36.00
Farm Market Price ($/bu, *$/lb)	6.10	4.50	*0.20	*0.26	9.40	9.50
Cash Inflow ($/acre)	262.30	279.00	306.00	468.00	235.00	342.00
Cash Outflow -E ($/acre)	140.00	130.00	150.00	240.00	125.00	210.00
Cash Outflow-I ($/acre)	151.30	143.50	172.25	291.30	142.00	234.50
Net Cash Flow-E ($/acre)	122.30	149.00	156.00	228.00	110.00	132.00
Net Cash Flow-I ($/acre)	111.00	135.50	133.75	176.70	93.00	107.50
Net Return-E ($ per acre)	12.30	39.00	46.00	118.00	0.00	22.00
Net Return-I ($ per acre)	1.00	25.50	23.75	66.70	-17.00	-2.50

Source: Estimation is based on the information in the SaskSim Simulation Game Manual.
Note: E – excluding crop insurance premium per acre and I – including crop insurance premium per acre.

that the standard deviation of the crop yield and price is approximately 83% and 69% of their means. As a result, chickpeas have the highest CV indicating a higher risk level. For example, using the means of the prices and yields of the crops as well as their total variable costs and fixed costs, the net income per acre are estimated and presented in Table 8.

In comparison with flax, malt barley, canola and spring wheat, chickpeas and red lentils remain the crops with the highest coefficient of variation and highest net income per acre without crop yield insurance. Although the coefficient of variation for flax is higher than malt barley, the net income of malt barley is substantially higher than flax. Crop yield insurance is one of the major risk mitigation strategies in the simulation game. The other risk mitigation strategies are low-risk crops and crop diversification. Participants in the simulation game have the option of taking crop yield insurance and or diversifying their crops to minimize losses.

Figure 3 displays the net income per acre of each crop in a portfolio and their percentage contribution to the net farm income. In elaboration, assuming a participant selects a crop portfolio comprising spring wheat, malt barley, red lentils, chickpeas, flax and canola,



Note: An example of crop portfolio consisting of wheat, barley, red lentils, chickpeas, flax and canola.

Figure 3: Percentage of Net Income Per Acre in a Crop Portfolio

each of the crops' net income per acre contribution to the net farm income is presented in Figure 3. The estimation is based on the means and standard deviations of the prices and yields. Figure 3 indicates the relationship between the net income per acre without crop yield insurance and the net income per acre with crop yield insurance. Overall, chickpeas contribute the highest income to the net farm income without crop yield insurance and with crop insurance. Red lentils contribute approximately 19.38% (second to chickpeas) to the net farm income when planted without crop yield insurance. However, malt barley contributes more than red lentils if crop yield insurance is purchased for both crops. As seen from Table 7, canola is among the less risky crops. Canola contributes negatively to the net farm income if crop insurance is purchased for this crop. Though flax is the third riskiest crop based on the coefficient of variation, canola with the lowest coefficient of variation contributes higher net income per acre to net farm income than flax if planted without crop yield insurance. Even with crop yield insurance, canola has a lesser negative impact on farm income than flax. Red lentil is the second riskiest crop, followed by flax, malt barley, spring wheat and canola based on the coefficient of variation. However, Figure 3 shows that their net income per acre do not commensurate with their risk level based on their coefficient of variation. Therefore, the decision to grow a particular crop depends on whether it is worth choosing the crop based on the standard deviation of the expected net income per acre and whether it is appropriate to take crop yield insurance. Participants' level of entrepreneurial orientation influences their crop choices tremendously.

4.2 Description and Summary of Survey on Management Style

Risk attitudes vary widely among farmers around the world. Risk mitigation strategies largely depend on the farmer's level of entrepreneurial orientation (Schillo 2011). The entrepreneurial orientation questionnaire contained several parts, including demographics and management style. Table 9 provides the demographic information of the participants in the simulation game. Thirty-six participants in both BPBE 322 and BPBE 320 class identified their program of study as agribusiness. The number of students pursuing agronomy, agronomy and agribusiness, animal science and environmental science were twenty-seven, one, two and one respectively (see: Table 9) for information on gender and age range). Preliminary testing revealed that participants' program of study has no significant effect on their crop choices. Even though the class a participant belongs to has a significant effect on his/her crop choices. It can be said that the academic knowledge on farming that the participants have gained would give them more insights on farming risk mitigation. This intends to increase the participant's theoretical knowledge on farming risk mitigation and therefore, increase their level of experience.

Managerial experience is, withal a crucial part of the analyses of risk mitigation. Initial analysis shows that thirty-two students grew up on a farm where they were part of the decision-making process.

Table 9: Demographic of the EO Survey

Program of Study	Total	**Gender**	
Agribusiness	36	Male	43
Agronomy	27	Female	24
Agribusiness and Agronomy diplomas	1	**Age Range**	
Animal Science	2	18-24	59
Environmental Science	1	25-44	8
Total	67		

The majority of the students that grew up on a farm identified as having a high level of managerial experiences.

On average, the survey took approximately twelve minutes to complete. Table 10 provides descriptive statistics for the survey on management style. The respondents are the participants of the BPBE 322 and BPBE 320 classes in the simulation game. Question seven considers the participant's level of experience in farming with a mean of 3.18 (on a five-point scale) with one and five being the lowest and the highest level of farm experience respectively. Questions eight and nine measure the participants' level of innovativeness and pro-activeness on a seven-point scale. Question ten to twelve assess the participants' level of competitiveness and questions thirteen and fourteen measure the participants' level of risk (risk-loving, risk neutral or risk-averse – all on a seven-point scale – see: Appendix 2). Overall, the results indicate that the majority of the participants in class one and two do not have a high level of entrepreneurial orientation. Questions eight to fourteen indicate that participants EO dimensions' scores were below 6.00 (a score of 6.00 to 7.00 on a seven-point scale constitutes a high level of the item in question and represent those in the top box). Approximately 17.9% of the respondents were identified as having a high level of farm experience (Question 7 – see: Table 10 – Top box). The participants who ticked point four or five on a five-point scale are classified as those in the top box with high level of farm experience. Any point below three indicates low level of farm experience, whereas point above three signifies high level of farm experience. The measurement of the entrepreneurial orientation scores as stated already used

Table 10: Results - Survey Questions: Management Style

Question No.	Description	Mean	Standard Deviation	Agree	Top Box
7	How would you rate your experience with farm business if you grew up on a farm or if you personally manage a farm business?	3.18	1.34	46.27%	17.91%
8	*In general, we favour:* a)strong emphasis on the use of tried and true products or services for our business; b)strong emphasis on using new products and services, technological leadership, and innovations	3.72	1.03	26.87%	0.00%
9	*How many new lines of products or services has your business marketed during the past three years?* A. Changes in product or service lines have been mostly of a minor nature B. Changes in product or service lines have usually been quite dramatic.	3.16	1.03	14.71%	0.00%
10	*In dealing with competitors my/our business:* A. Typically responds to actions which competitors' initiate; B. Typically adopts a very competitive attitude, not avoiding clashes with competitors	3.76	0.97	25.37%	0.00%
11	A. Typically seeks to avoid clashes with competitors, preferring a live-and-let-live attitude; B. Typically adopts a very competitive attitude, not avoiding clashes with competitors	3.48	0.95	16.92%	0.00%
12	*In general, we:* A. Tend to focus on low-risk investment projects (with normal and certain rates of return); B. Tend to go for high-risk investment projects (with chances for very high returns).	3.39	1.04	19.40%	0.00%
13	*In general, we believe that:* A. Given the nature of the business environment, it is best to explore our options gradually via cautious, incremental behaviour; B. Given the nature of the business environment, bold, wide-ranging acts are necessary to achieve the business's objectives	3.24	0.85	10.29%	0.00%
14	*When confronted with decision-making situations involving uncertainty, we:* A. Typically adopt a cautious wait and see attitude in order to minimize the probability of making costly decision; B. Typically adopt a bold, aggressive attitude in order to maximize the probability of exploiting potential opportunities.	3.40	0.87	10.29%	0.00%

the average of the items from question eight to fourteen on each entrepreneurial dimension. The participants completed the EO survey once. Whether their scores changed over the periods are unknown. The level of EO score determines the level of innovativeness, pro-activeness, competitiveness and risk-taking of a participant. A higher EO score shows that the participant is highly entrepreneurial oriented and vice versa.

4.3 Preliminary Results of Simulation Game and Survey on Management Style

The analysis of the relationship between the simulation game results and the EO scores is crucial to understanding the reasons behind the participants' decisions on crop choices and crop yield insurance. The six crops participants can grow have different levels of total risk index and their respective average net revenue. Hence, the types of crops participants choose could have repercussions on their farm business performance. Importantly, participants' risk attitudes determine their choice of crops. The information the participants completed on the EO survey on management style provide insights into their decisions and crop choices. In analyzing the participants' farming risk mitigation strategies, the study critically examines the link between the information obtained from the SaskSim Simulation Game (SSG) and the EO survey on management style. The descriptive statistics provides a basic perspective on the relationship between the two results. The analysis considers the correlation among the variables and the panel data analysis takes into account the time series and cross-sectional nature of the information.

In the SaskSim Simulation Game, the question of how the participants mitigate risk impacts depends on their decisions on crop choices and crop yield insurance. Figure 4 shows that the participants' average CPWRI decreased throughout the entire periods of farming. However, the average CPWRI increased slightly during period four and at the same time, the average EO score decreased. It is very clear that, most participants were planting low-risk crops after period one. It is worthwhile to note that between period three and four, the average CPWRI and the average EO score increased and decreased slightly respectively. The continuous decrease in the average EO could either be attributed to the fact that some participants without funds dropped out of the game or voluntarily dropped out. In the same way, a participant with a very high EO score could either go out of business, leading to a decrease in the average CPWRI. In spite of this, it is expected that, participants' level of EO should influence their crop choice decisions. The trend shows a continuous decrease of CPWRI for most participants. In comparison with period two, it can be inferred that the majority of the participants in the simulations have a higher CPWRI during period one, possibly because they grew higher-risk crops. Besides, between period three to four inclusive, the participants' average CPWRI fell and rose after period three. The means (standard deviations) of the CPWRI are 132.15 (75.07), 123.11 (71.43), 148.10 (71.43) and 115.24 (55.74) for period two, three, four and five respectively for all the participants in the two classes combined.

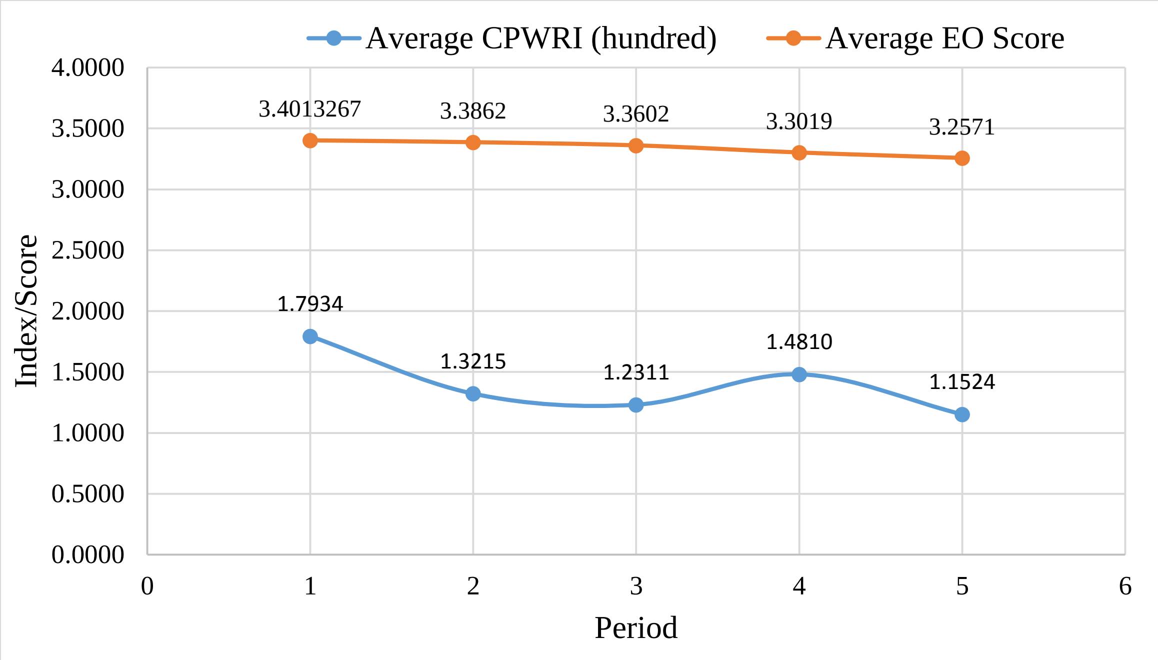


Figure 4: Relationship between the Averages of CPWRI and EO Score

The numbers indicate that participants were maintaining approximately the same portfolio of crops over the periods. The standard deviations of the average of CPWRI could be an indication that participants growing similar crops and or introducing few new crops into their portfolio. The standard deviation of the CPWRI of the participants' decreased from 56.81% to 48.23% of their means between period two to four. The numbers indicate that the gap in the participants' CPWRI was reducing over the periods. Participants were choosing a few new crops to plant and or maintaining their crop portfolio. Perhaps a portfolio of crops, which earns more net returns. Overall, in comparison with period one, the majority of the participants from period two to five inclusive grew lower-risk crops, whereas the overall averages for the EO decreased continually every period.

The varying level of the participants' CPWRI is evidence of different approaches to risk management. In an interview with two participants whose net worth were below zero, they stressed that the SaskSim Simulation Game mimics the true world of farming. The assigned codes or names of the interviewees (participants) were not identified due to the rules governing the conduct of such simulation games. The participants in question did not also consent to revealing their identity. The participants believed that possibly a series of fortuitous decisions on crop choices will help them advance in the game. Nevertheless, to these participants losing is as if reality fell away and dissonance between claim and fact filled the void. This confirms the different managerial philosophies and salient beliefs of the participants. Some participants are risk-averse, risk loving, or could be neutral in their approach to farming risk mitigation. Determining risk attitudes that could enhance farm business financial performance is a general problem that has perplexed many farmers and farm lenders

4.4 Findings and Discussion

The descriptive statistics of the variables are depicted in Table 11 excluding the dummies.

Table 11: Descriptive Statistics of the Variables (Non-Categorical)

Variable (Unit)	Mean	Standard Deviation	Maximum	Minimum
CPWRI (Standard Deviation of Crop Portfolio)	129.64	64.09	485.26	60.47
Entrepreneurial Orientation (Score)	3.36	0.70	5.00	1.00
Crop Diversification (Index)	0.47	0.23	0.83	0.00
Competitive Aggressiveness (Score)	3.60	0.89	5.50	1.00
Innovativeness and Proactiveness (Score)	3.49	0.91	5.50	2.00
Risk-Taking (Score)	3.42	0.78	5.00	2.00
Level of Farm Experience (Score)	3.23	1.39	5.00	1.00

The estimated results of the multivariate panel regression model are presented in Table 12. The main focus of the thesis being the relationship between crop portfolio weighted risk index and the level of entrepreneurial orientation, it is of importance to note that the coefficient of independent variable EO turned out to be significant. The coefficient being positive and significant implies that risk of portfolio increases with the level of entrepreneurial orientation. Thus, a higher risk index is associated with a higher EO score and vice versa. This unsurprisingly unmasked that farmers with a higher level of entrepreneurial orientation have a higher risk index of crop choices.

Table 12: Results of Multivariate Panel Regression of Crop Portfolio Weighted Risk Index

Independent Variables/Items	Estimated Coefficient/Values (including EO)	Estimated Coefficient/Values (including EO dimensions & LFE)
Constant	63.6699***	91.0044**
	(22.4971)	(46.0868)
Level of Entrepreneurial Orientation (EO)	16.9418***	
	(5.9641)	
Innovativeness and Proactiveness (IP)		1.1931
		(3.0944)
Competitive Aggressiveness (CA)		2.2758
		(8.1679)
Risk- Taking (RT)		8.0170**
		(5.2647)
Grew Up on Farms (GUF)	16.5847*	13.1965
	(8.9127)	(8.4706)
Level of Farm Experience (LFE)		5.9755
		(3.5981)
Gender (G)	14.7232***	13.7118***
	(4.3198)	(3.7688)
Age Range (AR)	2.2006	2.9405
	(3.9301)	(4.3077)
Class of Participant (C)	-24.0709***	-33.1382*
	(7.1986)	(17.6049)
Prob(F-statistic)	0.0010	0.0596

Notes: (a) Values in parentheses represent White cross-section corrected standard errors.
(b) *, ** and *** Significant at 10, 5, and 1 percent level respectively.

The simulation game and the survey expose the view that, farmers with a higher level of entrepreneurial orientation are more likely to grow crops with higher price risks and higher yield risks. Thus, a higher level of EO positively influences CPWRI. This further emphasized that, the participants with high-level EO scores grew mainly high-risk crops. The coefficients for the entrepreneurial dimensions except risk-taking were statistically insignificant, however, all positive as expected. The coefficient of risk-taking (RT) is significant indicating that risk-loving participants grew high-risk crops or their crop choices mostly consist of high-risk ones such as chickpeas and red lentils. The coefficients of level of farm experience and the dummy variable for whether or not participants grew up on a farm were positive, but statistically insignificant. However, the coefficient of the dummy variable for whether or not participants grew up on farm was positive and significant in the model including the entrepreneurial orientation scores (see: equation (9.1))

The results, therefore, reinforce confidence in previous empirical test on entrepreneurial orientation (see: Covin and Slevin 1989; Covin *et al.* 2006; Lumpkim and Dess 1996; Coulthard 2007; Hanson *et al.* 2007; Kimura *et al.* 2010; Kreiser and Davis 2010; Deligianni *et al.* 2015). The higher the CPWRI, the higher the EO score in general. Although the trend is fairly strong, the results do not lead to unequivocal conclusion as to whether participants' level of entrepreneurial orientations change over time. There may be several factors that would compel the participants to change their risk attitudes and managerial philosophies. Nevertheless, these were not observed as the participants completed the EO survey only once. In spite of this, the sign of the coefficient of EO came as expected and conformed to previous empirical test on the relationship between EO and crop choices in general. Thus, if more entrepreneurial orientated farmers grow high-risk crops, then there is a strong positive relationship between the level of EO and crop portfolio weighted risk index.

Among the categorical independent variables, the coefficient of gender has come out to be statistically significant, whereas the coefficient of age range was not significant. The coefficient of the control variable, gender is positive and suggests that crop portfolio weighted risk index is significantly higher in the male participants than in the female participants. This presupposes that, in comparison with male participants, female participants grew low-risk crops. Thus, male participants took higher risk compared to female participants. Similarly, participants who grew up on farm are more likely to grow higher-risk crops than those without any prior farm knowledge as stated earlier.

The sign of the estimated coefficient of the class-specific dummy and its significance level implies that crop portfolio weighted risk index is higher among participants in BPBE 320 class than those in BPBE 322 class. The result is an indication that participants in the BPBE 322 grow lower-risk crops. It is noteworthy that the sign of the coefficients and their statistical significance remained the same irrespective of how the model is tested.

Table 13 presents the results of the multiple panel regression of crop diversification index and crop yield insurance index on the level of entrepreneurial orientation and other

Table 13: Results of Multivariate Panel Regression of Crop Diversification and Crop Yield Insurance

Dependent Variables Independent Variables/Items	Estimated Coefficient/Values) *Crop Diversification* (CEI_{CD}	Estimated Coefficient/Values *Crop Yield Insurance (CYI)*
Constant	0.5421***	-3.6456***
	(0.0807)	(1.3298)
Level of Entrepreneurial Orientation (EO)	0.0261*	-0.1910
	(0.0192)	(0.2868)
Grew Up on Farms (GUF)	0.0469	0.5008
	(0.0508)	(1.2038)
Gender (G)	0.0017	0.8112
	(0.0142)	(0.7361)
Age Range (AR)	0.0453	0.1792
	(0.0345)	(0.5583)
Class of Participant (C)	-0.1651**	1.7729***
	(0.0637)	(0.5731)
Prob(F/LR-statistic)	0.0000	0.0001

Notes: (a) Values in parentheses represent White cross-section corrected standard errors.
(b) *, ** and *** Significant at 10, 5, and 1 percent level respectively.
CYI: the estimation using the Probit and Logit on the panel data yielded similar results *(see: Appendix 3.1).

categorical variables. When the crop diversification index is regressed on the entrepreneurial orientation scores together with other categorical variables, the sign of the coefficients is similar to those presented in Table 12. The coefficient of entrepreneurial orientation score being statistically significant and expectedly positive suggesting that diversification increases as the level of entrepreneurial orientation increases. Entrepreneurial oriented participants are more likely to use crop diversification as a risk mitigation strategy. On the contrary, Entrepreneurial oriented participants are less likely to use crop yield insurance as coefficient is negative, however, statistically insignificant. The coefficients of the dummies whether participants grew up on far, gender and age range were all positive in both cases, but statistically insignificant. The sign of the estimated coefficient of the class-specific dummy and its significance level implies that crop diversification index is higher among participants in BPBE 320 class than those in BPBE 322 class. This is because crop diversification helps mitigate risks associated with prices and yields. A lower risk index is a result of a higher level of crop diversification as a risk mitigation strategy. Moreover, it is worth noting that crop diversification was one of the major two risk mitigation strategies available to the participants in the SaskSim. However, the coefficient of the class dummy for crop yield insurance indicates that participants in BPBE 320 compared to those in BPBE 322 were less likely to use crop yield insurance as a risk mitigation strategy.

Moreover, the relationship among other variables was captured using correlational analysis in e-views. Crop diversification and crop yield insurance are the two main risk mitigation strategies in the SaskSim Simulation Game. Crop insurance is a traditional risk management strategy. Crop diversification helps to reduce the risk impacts. The crops participants grow determines their overall crop portfolio weighted risk index. As noted in the thesis, chickpea is the riskiest crop followed by red lentils. Participants could specialize in any one crop by growing only one crop throughout. In this case, the participant would have crop diversification index of zero, although they chose a high-risk crop. However, if the participant grows more than one, but consisting of only chickpeas their crop diversification index and crop portfolio weighted risk index would go up simultaneously. In a different scenario, a participant that grows more than one crop consisting of different crops with different total risk index would have a different crop portfolio weighted risk index. Therefore, participants could mitigate risk by growing a combination of crops with varying total risk index. The higher the level of diversification (consisting of different crops), the lower the crop portfolio weighted risk index. The correlation between crop portfolio weighted risk index and crop diversification index predicates an inverse relationship. There is a negative correlation between crop diversification index and crop portfolio weighted risk index ($r = -0.1653$). Crop portfolio weighted risk index decreases as crop diversification increases. This presupposes that, a higher level of crop diversification led to a lower crop portfolio weighted risk index. Even though the correlation is a considerably smaller effect, it gives substantial evidence to support the use of crop diversification to mitigate farming risks.

Similar results applied to the relationship between crop portfolio weighted risk index and index of crop yield insurance. The dummy variable for distinguishing participants who relied on crop yield insurance as a risk mitigation tool from those who did not was negatively correlated to crop portfolio weighted risk index. The trend of correlational relationship between the crop portfolio weighted risk index and crop yield insurance is small ($r = -0.1487$). Thus, crop yield insurance is used as a risk mitigation strategy. The negative relationship between crop portfolio weighted risk index and crop yield insurance signifies that crop insurance is a simple risk mitigation strategy.

The correlation between the level of entrepreneurial orientation and crop portfolio weighted risk index is positive. In other words, for those participants who responded to the EO survey, higher level of EO score was correlated with higher crop portfolio weighted risk index, although the correlation ($r = 0.1826$) is a considerably small effect. Similar results applied to the relationship between participants' level of entrepreneurial orientation and the crop diversification: there is a small positive relationship between the EO scores and crop diversification index ($r = 0.0873$). The SaskSim participants with high EO scores were more likely to rely on crop diversification to mitigate risk impacts. Regardless of the fact that the correlation effect is negligible, the outcome is useful considering the fact that a priori knowledge of their relationship in previous empirical studies and the present research is meagre. In spite of the fact that participants with high EO scores increased their use of crop diversification, participants with low EO scores decreased their reliance on crop diversification as a risk mitigation strategy. This confirms that participants with high level of entrepreneurial orientation are more profit-oriented, more innovative, proactive, risk loving and less likely to rely on crop yield insurance. The participants with high EO scores grew higher-risk crops and were more willing to resort to crop diversification. Thus, the participants with high EO scores are more inclined to use crop diversification rather than crop yield insurance. The reverse is true.

The negative correlational relationship between the EO scores and crop yield insurance means that, whilst participants with a high EO scores are less likely to rely on crop yield insurance, participants with a low EO score are more likely to rely on crop yield insurance as a risk mitigation strategy. Differently, participants with high EO scores relied on crop diversification to enhance their farm financial performance and they were less inclined to use crop insurance. The participants with high EO scores grow high-risk crops. It follows that participants with a high EO scores prefer crops with high-risk index without taking crop yield insurance. The participants with low EO scores have preferences for lower-risk crops and at the same time, they are more likely to rely on crop yield insurance.

The multiple regression results of income generation in the SaskSim farms (NFI) have been outlined in Table 14. The positive and significant coefficient of crop diversification index implies that a higher level of crop diversification is associated with a higher level of net farm income. Thus, the greater the level of crop diversification, the more is the net farm income. The result is not surprising as crop diversification lessens risk impacts and increases net farm income. Participants who therefore diversified their farms largely earned more income. In the same way, crop yield insurance is positively related to net farm income, however, statistically insignificant.

On the other hand, the estimated coefficient of crop portfolio weighted risk index is significant and expectedly negative. This means that a lower crop portfolio weighted risk index is associated with a higher farm income. This is usually not the case in the real world of farming. However, the participants who used crop diversification and/or crop insurance to mitigate risk earn more income in the SaskSim Simulation Game. Normally, a higher risk is

Table 14: Results of Multiple Panel Regression of Net Farm Income

Independent Variables/Items	Estimated Coefficient/Values) (Includes EO, CPWRI)	Estimated Coefficient/Values (Includes EO, CEI, CYI)
Constant	5.9233***	5.8889***
	(0.0648)	(0.0429)
Level of Entrepreneurial Orientation (EO)	0.0165**	0.0088*
	(0.0082)	(0.0081)
Crop Portfolio Weight Risk Index (CPWRI)	-0.0003*	
	(0.0003)	
Crop Diversification Index (CEI_{CD})		0.0871**
		(0.0870)
Crop Yield Insurance (CYI)		0.0385
		(0.0751)
Prob(F-Statistic)	0.4881	0.6297

Notes: (a) Values in parentheses represent standard errors.
(b) *, ** and *** Significant at 10, 5, and 1 percent level respectively

associated with a higher farm income. For example, it can be seen from Figure 3 that chickpeas have the highest coefficient of variation, yet it is the crop with the highest net income per acre. It is noteworthy that all the students who took part in the SaskSim Simulation Game were ranked based on their net farm income irrespective of whether or not they completed the EO survey. The findings revealed that, participants who grew mostly chickpeas and red lentils (the two top riskiest crops) throughout the entire five decision periods earned the highest net farm income. It is clear from the results presented in Table 14 that these participants who earned the highest net farm income by growing only high-risk crops did not take part in the EO survey and thus, were excluded from the analyses. Next, the participants with crop diversification also earned more farm income. Risk mitigation strategies therefore play an important role in farm income enhancement. The results from the simulation game suggest that participants risk mitigation strategies affect their farm business financial performance.

The relationship between the level of entrepreneurial orientation and farm income is also of prime focus in this thesis. The coefficient of the level of entrepreneurial orientation is significant and positive as expected in both cases. A higher level of entrepreneurial orientation is associated with a higher level of net farm income. The coefficient indicates that participants with high EO scores earn more income. The result offers clues to the relationship that exist between EO scores and net farm income. SaskSim Simulation Game participants with high entrepreneurial scores earn more income, although this largely depended on their attitudes toward crop diversification and crop yield insurance.

4.5 Chapter Conclusion

The chapter considered the relationship between the data from the SaskSim Simulation Game and survey of entrepreneurial orientation. The participants in the simulation game were students from the BPBE 322 class and BPBE 320 class. The simulation game allows the student-participants to make decisions on crop choices, crop diversification and crop yield insurance for a period of five years. Each decision period is considered as a year. Participants can grow any or combination of crops including spring wheat, malt barley, red lentils, chickpeas, flax and canola. Each participant is given four sections of farmland and a start-up capital of $500,000. Participants are allowed to rent or buy more farmland by borrowing. As such, prices and yields for each period in round one were different from those in round two. Participants taking part in the simulation game were also asked to complete an EO survey. The survey comprises several questions to evaluate the participants' level of entrepreneurial orientation. In all sixty-seven (67) students took part in the simulation game and fully completed the EO survey. The game ended with thirty-five (35) participants from both BPBE 322 class and BPBE 320 class.

The analyses of the data revealed that participants with higher EO scores grew higher-risk crops. Thus, crop portfolio weighted risk index is higher among participants with a higher level of entrepreneurial orientation and vice versa. Besides, the correlational relationship between crop diversification index and crop portfolio weighted risk index was negative as expected. Participants with high crop diversification index have low crop portfolio weighted risk index. These participants used crop diversification as a risk mitigation tool. In the same way, crop yield insurance was negatively correlated to crop portfolio weighted risk index. The correlational relationship suggests that participants used crop yield insurance to mitigate farming risks, but crop diversification was largely used as mitigating tool as its correlational coefficient was larger.

In addition, the gender of the participants and their class have a significant influence on the crop portfolio weighted risk index, crop diversification and crop yield insurance. Male participants in the simulation game generally have higher crop portfolio weighted risk index compared to their female counterparts. Also, the participants in the BPBE 322 class have lower crop portfolio weighted risk index and lower crop diversification index in comparison with those in the BPBE 320 class. However, the participants in the BPBE 322 class have higher crop yield insurance in comparison with those in the BPBE 320.

Crop diversification and crop yield insurance enhance farm income. However, crop diversification contributes to a greater extent than crop yield insurance. Besides, participants with high entrepreneurial orientation scores earned more income in the SaskSim Simulation Game. Net farm income increases as crop portfolio weighted risk index decreases. This is typically contrary to the situation in the real-world of farming. However, the results indicate that participants who largely relied on crop diversification to mitigate the crop portfolio weighted risk index earned more farm income. The findings from the simulation game and the survey response provide some support for the fact the more entrepreneurial oriented farmers are the more they are likely to choose high-risk crops and vice versa. Entrepreneurial oriented farmers are more inclined to use crop diversification rather than crop yield insurance.

Chapter 5. Conclusion

5.1 Review of Research Objectives and Results

Farmers make decisions on crop choices and crop yield insurance every day that affects their farm operations. Farming risk mitigation is therefore a topic on agenda of an increasing number of farmers and researchers around the globe. The level of entrepreneurial orientation determines risk mitigation strategies and shapes the entire decision making processes of the farmer. Farmers who are more entrepreneurial oriented are more innovative, proactive and risk loving (Covin and Slevin 2006; Nguyen *et al.* 2007). In analyzing the risk mitigation decisions and choices of farmers, the thesis employed a simulation game and entrepreneurial orientation survey to investigate student-participants' risk mitigation strategies. The participants were students from the University of Saskatchewan and mimicked the activities of real-world farmers in the simulation game. The purpose is to study farm management decisions that entrepreneurial oriented farmers make to mitigate risk impacts.

The research explores different situations that steer the decisions and choices of farmers. The level of entrepreneurial orientation positively affects participants' crop choice. The entrepreneurial dimensions, such pro-activeness and innovativeness, competitive aggressiveness and risk-taking all positively affects participants' weighted risk index of crop choices. The higher the level of risk-taking, the higher the crop portfolio weighted risk index. The model also confirms that; a higher level of entrepreneurial orientation n is associated with a higher crop portfolio weighted risk index. That is, participants with a higher level of entrepreneurial orientation are more likely to grow higher-risk crops. The result is not surprising because highly entrepreneurial oriented farmers are expected to grow high-risk crops as they are more profit oriented.

The hypotheses testing reveals that farming risk mitigation depends on crop diversification and crop yield insurance. The analyses confirm that participants in the simulation game used crop diversification and crop yield insurance as risk mitigation tools. Nevertheless, participants with high EO scores are more likely to use crop diversification and less likely to use crop insurance to mitigate risk impacts. Thus, high EO scores were positively correlated with crop diversification. The study also brought to light that, participants with low EO scores mostly relied on crop yield insurance to mitigate risk impacts. This presupposes that, participants whose EO scores were high relied on a crop diversification to sustain their farm business performance. It also became clear that the participants' financial position increased with crop diversification and the level of entrepreneurial orientation.

Among the dummy variables, male student-participants in the simulation game grew high-risk crops compared to their female counterparts. This presupposes that the male student-participants have higher EO scores than the female students as the EO level is positively correlated with the crop portfolio weighted risk index. Besides, the participants in BPBE 322, which comprised mainly of agribusiness students, were less inclined to use crop diversification compared to BPBE 320, mainly agronomy students. Agronomy student-participants grew high-risk crops, whereas agribusiness student-participants grew mainly lower-risk crops. However, in comparison with the student-participants from BPBE 320 class, those in BPBE 322 (agribusiness) class were more willing to use crop insurance as a risk mitigating tool. Even though BPBE 322 student-participants have lower crop portfolio weighted risk index compared to those in BPBE 320, those from BPBE 322 class still prefer crop insurance to crop diversification in mitigating farming risk. It also came to light that a lower crop portfolio weighted risk index is associated with a higher net farm income. Thus, agribusiness student-participants earned considerably high net farm income than those in the BPBE 320 class.

5.2 Implication

The level of entrepreneurial orientation helps predict the risk mitigation strategies of farmers. The type of risk mitigation strategy a farmer chooses would have an impact on their farm income. As the results reveal, although contrary to what has been perceived, participants who grew mainly lower-risk crops earn greater net farm income. Irrespective of the validity of this conclusion, such information would aid financial institutions, government agencies and crop insurance companies in their partnership with farmers. The thesis acknowledges that a very broad analysis using reliable data from real world farmers would provide more accurate foundations upon which policy makers can base their decisions.

Financial institutions are interested in knowing whether a farmer who wants to borrow money is likely to succeed in their farm business. Assuming entrepreneurial orientation scores accurately predict farmers' choice of crops, inclination to use crop insurance and other mitigation strategies not identified in this thesis as well as their likely effect on net farm income, financial institutions can decide optimistically whom to lend money to. It would also help financial institutions to promote their interest and as well provide the necessary advice to farmers. Thus, financial institutions can channel their resources in ways that accomplish their short and long term goals. For example, knowing the EO score of a farmer, their crop choices and expected net farm income, financial institutions can easily decide on the lending rate or interest, and whether or not to even lend capital to a farmer.

Government agencies and insurance companies are interested in promoting efficient farm business practices. In most cases, government agencies in question end up providing financial or material support to farm businesses, which are in fact likely to fail. The thesis, therefore, provides insights on the attitudes of farmers that likely lead to enhancement of farm income. The results in the thesis provide analytical basis for assessing farmers' eligibility to receive financial aid based on government directives and interest. Insurance companies would benefit in numerous ways. Insurance companies can develop premium plans based on the farmer's level of EO and their crop choices. Also with explicit knowledge of crops and their risk level, insurance companies would be able to indemnify farmers that commensurate with the crop risk.

The SaskSim Simulation Game and the EO survey on management style therefore attempts to analyze the managerial philosophies and risk attitudes of farmers. Although future research is needed to develop accurate basic models for such assessment, the current research represents an important contribution to literature on risk mitigation analysis and a stepping-stone for future research on building models that will help institutions to correctly predict the relationship between the level of EO and crop choices. Amid scarce resources and governments' support for most efficient farm businesses, the SaskSim Simulation Game, in part provides insights into the world of farming and what risk mitigation attitudes or methods that agricultural policy makers should consider or promote.

5.3 Limitation of Study and Future Research

Although the simulation game strategy mimics a true farm business management, there are several obstacles. Participants were students and assumed the position of a real farmer. There is the likelihood that some of the participants might not have understood the entire simulation game. This is vivid in the data as there were numerous data-entry errors. Beside, the low mean values of the items on the entrepreneurial orientation indicate that the participants have low EO scores. Perhaps, running the simulation game using real world farmers would provide more clarifications and reliable conclusions.

Besides, the SaskSim Simulation Game could be restructured to allow participants to complete the survey on management style every period. The changes in the level of entrepreneurial orientation are crucial to understanding the variations in the average risk index of crop choices. This could help in determining whether the participants' level of entrepreneurial orientation changes with their farm performance level. In addition, the relationship between net farm income, crop portfolio risk index and crop insurance could be tested with larger sample size for more accurate results.

Another scenario is to relax the assumption of price-takers in the competitive market. The future SaskSim Simulation Game could develop demand and supply functions to determine prices and yields. That is, the program could consider the participants as a community of farmers in which the level of crop yield affects the entire price in the farm market. Other issues that were not discussed in this thesis are buying or renting of land. Future study needs to consider if either buying or renting of farmland affects farm business performance as well as how participants financial position affects their choice of crops.

The models used to analyze the data are derived through basic statistical methodologies and as such not all the variables have been empirically tested. Besides, future studies with the simulation game with larger sample size needs to test the reliability and stability of the data. This would help towards building a more advanced and a reliable common body of knowledge in farming risk mitigation.

5.4 Chapter Conclusion

The SaskSim Simulation Game and the EO survey on management style offers a new way of studying farming risk mitigation strategies. The game allows participants to make decisions on crop choices and crop yield insurance. The EO survey seeks to discover the ideas behind such decisions. The results from both sides show that there is a positive relationship between the level of entrepreneurial orientations and crop choices. The analyses unveil that participants with a high level of entrepreneurial orientation choose higher-risk crops. The simulation game brought to light, the use of crop yield insurance and crop diversification as farming risk mitigation strategies. Participants with higher EO scores are more inclined to use crop diversification, but less willing to use crop yield insurance to mitigate risk impacts.

The results would benefit financial institutions, government agencies and insurance companies. These agencies would be able to decide optimistically where to invest, how much interest to charge and devise a standard formulation for assessing farmers' likelihood of survival in the farm business. Any future research using real world farmers would help build more reliable results for use by policy makers. In spite of the limitations, the SaskSim Simulation Game provides a new promising way of analyzing the relationship between the level of entrepreneurial orientation, crop diversification and crop yield insurance without recourse to real-world farmers.

Reference

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Appendix

Appendix 1: Simulation Game (Bill Brown SaskSim 2015)

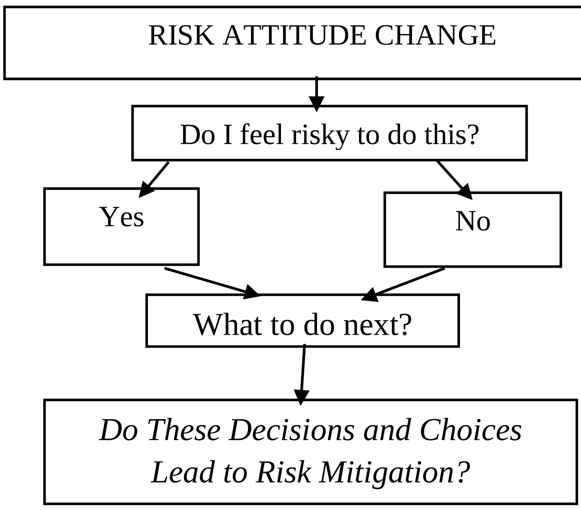
Appendix 1.1: The Concept of the SaskSim Simulation Game

Nature of Participants	Students at University of Saskatchewan
Nature of Business	Farming
Crop Types	Spring Wheat, Malt Barley, Red Lentils, Chickpeas, Flax, Canola
A: SaskSim Simulation Results (SSR)	Business Performance measured in terms of revenue
B: Survey Response (SR)	Factor-resources influencing SSR

Participants make basic decisions on:

- Crop selection/choice of crop to plant;
- Crop insurance;
- Decisions on crops to plant as market portfolio;
- Land acquisition: renting or buying

Decision-making Processes:



Appendix 1.2: User's Manual for SaskSim

Land

Each Participant is given 4 sections (2560 acres) of farm land to manage with the ability to buy ($640,000 each with $160,000 down and the rest borrowed at 4% over 20 years is $24,000 per year under a Constant Principal Repayment Plan), cash rent ($50 per acre with ½ due before seeding total $32,000) up to 12 more 640 fields of farm land. If the farm business is expanded beyond 8 fields the total machinery costs on the additional land will be $50.00 per acre higher than those on the first 8 sections of farm land to represent the fact that custom operators will have to be hired to do the work as the current machinery capacity in limited.

Crops

The potential crops to be grown and their associated means and standard deviations of prices and yields are as follows:

Crop	Mean Yield	Standard Deviation of Yield	Mean Price	Standard Deviation of Price
Spring Wheat	43 bu/acre	13 bu/acre	$6.10/bu	$1.55/bu
Malt Barley	62 bu/acre	27 bu/acre	$4.50/bu	$1.15/bu
Red Lentils	1,530 lbs/acre	1,000 lbs/acre	$0.20/lb	$0.12/lb
Chickpeas	1,800 lbs/acre	1,500 lbs/acre	$0.26/lb	$0.18/lb
Flax	25 bu/acre	12 bu/acre	$9.40/bu	$3.65/bu
Canola	36 bu/acre	10 bu/acre	$9.50/bu	$2.40/bu

Note: With normal distributions 68% of the observations will be within plus or minus 1 standard deviation from the mean and 95% of the observations will be within 2 standard deviations from the mean. No Price or Yield will ever go below zero.

Crop Insurance

Crop insurance is available on all crops. Crop insurance, when purchased, will guarantee a yield of 70% of the mean yield of the crop in question. The crop insurance premium per acre is as follows:

Crop	Crop Insurance Premium
Spring Wheat	$11.30/acre
Malt Barley	$13.50/acre
Red Lentils	$22.25/acre
Chickpeas	$51.30/acre
Flax	$17.00/acre

Canola	$24.50/acre

Cash (Variable) Costs of Production (not including crop insurance)

Crop	Cash (Variable) Cost of Production/acre
Spring Wheat	$140.00
Malt Barley	$130.00
Red Lentils	$150.00
Chickpeas	$240.00
Flax	$125.00
Canola	$210.00

Note: that 90% of the above costs need to be paid in the operation budget by harvest.

Other Noncash (Fixed) Costs

Noncash (fixed) costs of $110.00/acre will the charged to each acre of crop grown (no matter which crop is grown) whether land is owned, being purchased or rented. These costs will be subtracted from income after harvest.

Operating Cash

Each student will be given $500,000 cash to start the first year of SaskSim. Cash available in subsequent years will depend on the ending cash balance from the previous year. If the farm business runs out of cash your business will be shut down and you are eliminated from further decisions.

Appendix 1.3: Prices and Yields Drawn for Round One and Round Two

Items	Period 1		Period 2		Period 3		Period 4		Period 5	
Crop	Price	Yield	Price	Yield	Price	Yield	Price	Yield	Price	Yield
BPBE 322 Class										
Spring Wheat	$6.10/bu	43bu/acre	$6.57/bu	49bu/acre	$4.74/bu	**67bu/acre**	$5.91/bu	51bu/acre	$5.68/bu	39bu/acre
Malt Barley	$4.50/bu	62bu/acre	$4.40/bu	105bu/acre	**$2.20/bu**	75bu/acre	$6.39/bu	86bu/acre	$5.30/bu	8bu/acre
Red Lentils	$0.20/lb	1530lbs/acre	$0.05/lb	985lbs/acre	$0.19/lb	1621lbs/acre	$0.09/lb	3101lbs/acre	$0.26/lb	1742lbs/acre
Chick peas	$0.26/lb	1800lbs/acre	$0.31/lb	0lbs/acre	$0.15/lb	891lbs/acre	$0.16/lb	0lbs/acre	$0.42/lb	2936lbs/acre
Flax	$9.40/bu	25bu/acre	$6.64/bu	25bu/acre	$9.95/bu	35bu/acre	$9.84/bu	17bu/acre	$6.75/bu	13bu/acre
Canola	$9.50/bu	36bu/acre	$9.28/bu	95bu/acre	$12.89/bu	35bu/acre	$5.73/bu	41bu/acre	$13.61/bu	42bu/acre
BPBE 320 Class										
Spring Wheat	$6.10/bu	43bu/acre	$5.65/bu	47bu/acre	$6.68/bu	26bu/acre	$6.24/bu	47bu/acre	$6.70/bu	38bu/acre
Malt Barley	$4.50/bu	62bu/acre	$5.58/bu	43bu/acre	$5.36/bu	50bu/acre	$4.24/bu	46bu/acre	$6.57/bu	97bu/acre
Red Lentils	$0.20/lb	1530lbs/acre	$0.08/lb	1961lbs/acre	$0.38/lb	901lbs/acre	$0.00/lb	1058lbs/acre	$0.12/lb	688lbs/acre
Chick peas	$0.26/lb	1800lbs/acre	$0.32/lb	1752lbs/acre	$0.56/lb	4537lbs/acre	$0.00/lb	2592lbs/acre	$0.47/lb	1420lbs/acre
Flax	$9.40/bu	25bu/acre	$12.53/bu	34bu/acre	$7.18/bu	33bu/acre	$5.82/bu	16bu/acre	$9.78/bu	21bu/acre
Canola	$9.50/bu	36bu/acre	$11.40/bu	36bu/acre	$11.23/bu	38bu/acre	$12.33/bu	25bu/acre	$8.87/bu	46bu/acre

Appendix 2: Entrepreneurial Survey on Management Style

Appendix 2.1: Entrepreneurial Orientation Survey

	Demographics
Question 1	What is your major?
Question 2	What is your age? 18-24 45-64 64 +
Question 3	Gender Male Female
Question 4	Occupation Student (full time) Other (Please indicate)
Question 5	What year are you in your program (for students)? First year Second year Third year Fourth year
	Management Style
Question 6	Do you personally manage or have you ever managed a farm business if grew up on a farm where you were part of the decision-making process? Yes - No -
Question 7	How would you rate your experience with farm business if you grew up on a farm or if you personally manage a farm business? Scale (1) Poor (2) Fair (3) Average (4) Good (5) Excellent
Question 8	***In general, we favour***: A. strong emphasis on the use of tried and true products or services for our business; B. strong emphasis on using new products and services, technological leadership, and innovations Scale A: 1 2 3 4 5 6 7 :B
Question 9	***How many new lines of products or services has your business marketed during the past three years?*** A. Changes in product or service lines have been mostly of a minor nature B. Changes in product or service lines have usually been quite dramatic. Scale A: 1 2 3 4 5 6 7 :B
Question 10	***In dealing with competitors my/our business:*** A. Typically responds to actions which competitors' initiate; B. Typically adopts a very competitive attitude, not avoiding clashes with competitors

	Scale A: 1 2 3 4 5 6 7 :B
Question 11	A. Typically seeks to avoid clashes with competitors, preferring a live-and-let-live attitude; B. Typically adopts a very competitive attitude, not avoiding clashes with competitors Scale A: 1 2 3 4 5 6 7 :B
Question 12	***In general, we:*** A. Tend to focus on low-risk investment projects (with normal and certain rates of return); B. Tend to go for high-risk investment projects (with chances for very high returns). Scale A: 1 2 3 4 5 6 7 :B
Question 13	***In general, we believe that:*** A. Given the nature of the business environment, it is best to explore our options gradually via cautious, incremental behaviour; B. Given the nature of the business environment, bold, wide-ranging acts are necessary to achieve the business's objectives Scale A: 1 2 3 4 5 6 7 :B
Question 14	***When confronted with decision-making situations involving uncertainty, we:*** A. Typically adopt a cautious wait and see attitude in order to minimize the probability of making costly decision; B. Typically adopt a bold, aggressive attitude in order to maximize the probability of exploiting potential opportunities. Scale A: 1 2 3 4 5 6 7 :B

Explanatory Variables (Survey Responses)

Managerial Experience	Innovativeness and Pro-activeness	Competitive Aggressiveness	Risk-taking	Future Optimism/Pessimism
ME	IP	CA	RT	H5
Question 7	***Question 8-9***	***Question 10-11***	***Question 12-14***	***Question 9***

Appendix 2:2: Participant Consent Form

Participant Consent Form

Project Title:

Entrepreneurial Orientation (EO): Risk Analysis and Risk Management (**this study is part of a MSc thesis**)

Researcher:

Derrick Owusu-Kodua (MSc Student), U of Saskatchewan, BPBE Dept., 306 (966)-1981,
Email: derrick.owusu@usask.ca

Supervisor:

Prof. William J. Brown, U of Saskatchewan, BPBE Department, 306 (966)-4011,
Email: bill.brown@usask.ca

Purpose(s) and Objective(s) of the Research:

The current study is a part of MSc thesis and will explore the various ways in which farm business managers mitigate risk in a dynamic environment. Amid high degree of uncertainties in the agribusiness and its uniqueness, strategic risk management is a sine qua non of entrepreneurial orientation (EO). The research employs a game-like stimulation to gather information on how farm business managers mitigate risk in the decision-making process. Our current target group is students at all levels of their studies, irrespective of their program of study at the University. In the SaskSim Stimulation game, the participants will be provided with user's manual to enable them make decisions on the available resources. We also aim conducting similar project with non-students in the middle of the research. Based on the results from the simulation, we will highlight new directions for reliable guidance to risk mitigation in farm business management.

Procedures:

A questionnaire will be used to collect data. The survey is designed to capture the ideas/decisions farm business managers make in mitigating risk. The survey therefore offers explanations as to why farm business managers make certain decisions. The survey will first be conducted with BPBE 320 class. And the responses will be compared with the results from the SaskSim simulation game.

The project time is from 14/02/2015 to 30/06/2016.

The participants invited to fill out the surveys will be students at the BPBE 320 class.

The survey will be in electronic format. Participants will be provided with the link and can decide to answer/skip questions or entirely discard the survey. Students are free to decide if they want to take part by just answering the questions. The survey does NOT require students to enter their names or NSID.

Funded by:

Department of Bioresource Policy, Business & Economics (BPBE), College of Agriculture, University of Saskatchewan.

Potential Risks:

This is a minimal risk project which has no risk of psychological or emotional, physical, social. No aspects of the study are anticipated to include risk or harm to participants. Even though certain information such as standard deviations of crop price will not be released to participants, to all intents and purposes, this does not constitute deception as it aims to ensure that participants make decisions just like what farm business managers do amid uncertainties.

Confidentiality:

Confidentiality will be assured to all individuals who participate in the survey and SaskSim simulation game. Participants will be informed orally that their participation is voluntary, your answers will remain confidential and that you may withdraw at any time during the research process. If respondents choose to participate in the survey, it means that they agree and understand that their responses will be stored.

The data from this research project will be published and presented at conferences. As a participant you are not required to identify yourself in the survey. To enable the researchers to link your survey responses to the results from the SaskSim simulation game, participants will need to enter a number of their choice in both the survey and the simulation game. Because the participants for this research project are students in one class, all of whom are known to each other; it is possible that you may be identifiable to other people on the basis of, for instance, your communications with other student-participants. However, each participant's result will not be revealed and the researchers will not be able to identity participants by their responses to the survey. The information is collected in a raw date form and will be used for analysis only.

The data may be held longer if it is considered to be needed for researchers' future work but following the same considerations mentioned in this document regarding confidentiality and anonymity.

Right to Withdraw:

Participant can withdraw at any time without obligation.

Follow up:

The data gathered during the course of this project will be used for research and publications related to the project. In all cases the researchers will make every effort to ensure that participant anonymity and confidentiality are protected.

This research will have both a descriptive and an analytical component. Thus, the data collected in the survey will be used to develop economic models that will provide more insights about risk mitigation in entrepreneurial orientation. The findings will be presented to academic and non-academic audiences in conferences, workshops or public lecture format. The research will be published and presented in conventional outlets such as journals and conferences for the academic audience. And it will report to participant.

Questions or Concerns:

- Contact the researcher(s) using the information at the top of page 1;
- **This research project has been approved on ethical grounds by the University of Saskatchewan Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office**

ethics.office@usask.ca (306) 966-2975. Out of town participants may call toll free (888) 966-2975.

SIGNED CONSENT

Your signature below indicates that you have read and understand the description provided; I have had an opportunity to ask questions and my/our questions have been answered. I consent to participate in the research project. A copy of this Consent Form has been given to me for my records.

Name of Participant	_Signature_	_Date_

Researcher's Signature	_Date_

A copy of this consent will be left with you, and a copy will be taken by the researcher.

Appendix 3: Results – SaskSim Simulation Game

Appendix 3.1: Coefficient of Variation

Crop	Mean Yield	Standard Deviation of Yield	Variance of Yield	Coefficient of Variation of Yield	Mean Price	Standard Deviation of Price	Variance of Price	Coefficient of Variation of Price
	bu/acre (lb/acre)*	bu/acre (lb/acre)*			$/bu ($/lb)*	$/bu ($/lb)*		
1. Spring Wheat	43	13	169	0.30	6.1	1.55	2.40	0.25
2. Malt Barley	62	27	729	0.44	4.5	1.15	1.32	0.26
Red Lentils*	1530	1000	1000000	0.65	0.2	0.12	0.01	0.60
Chickpeas*	1800	1500	2250000	0.83	0.26	0.18	0.03	0.69
Flax	25	12	144	0.48	9.4	3.65	13.32	0.39
Canola	36	10	100	0.28	9.5	2.4	5.76	0.25

Crop	Total Risk Index of Crop	Std. Dev. of Net Returns Per ($100/ac)	Rank	Total Risk Index of Crop	Gross Revenue ($/ac)	Average Net Revenue ($100/ac)	Gross Revenue (with insurance - $/ac)	Cost of production/acre
Spring Wheat	0.556	1.066	5	10%	14%	$ 1.22	183.61	140.00
Malt Barley	0.691	1.417	4	13%	15%	$ 1.49	195.3	130
Red Lentils	1.254	2.709	2	23%	16%	$ 1.56	214.2	150
Chickpeas	1.526	4.853	1	28%	25%	$ 2.28	327.6	240
Flax	0.868	1.424	3	16%	12%	$ 1.10	164.5	125
Canola	0.530	1.315	6	10%	18%	$ 1.32	239.4	210

Appendix 3.2: Results of the Multivariate Panel Regression Model - CPWRI, CEI, and CYI

Dependent Variable: CPWRI
Method: Panel Least Squares
Date: 09/19/16 Time: 14:47
Sample: 2002 2005
Periods included: 4
Cross-sections included: 63
Total panel (unbalanced) observations: 230
White cross-section standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	63.66986	22.49708	2.830139	0.0051
EO_SCORE	16.94179	5.964134	2.840612	0.0049
GUF	16.58471	8.912679	1.860800	0.0641
G	14.72319	4.319787	3.408315	0.0008
AR01	2.200596	3.930094	0.559935	0.5761
C01	-24.07093	7.198632	-3.343820	0.0010

R-squared	0.087281	Mean dependent var	126.8686
Adjusted R-squared	0.066908	S.D. dependent var	64.09741
S.E. of regression	61.91599	Akaike info criterion	11.11517
Sum squared resid	858724.0	Schwarz criterion	11.20486
Log likelihood	-1272.245	Hannan-Quinn criter.	11.15135
F-statistic	4.284107	Durbin-Watson stat	1.599595
Prob(F-statistic)	0.000967		

Dependent Variable: CPWRI
Method: Panel Least Squares
Date: 09/19/16 Time: 14:49
Sample: 2002 2005
Periods included: 4
Cross-sections included: 63
Total panel (unbalanced) observations: 230
White cross-section standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	91.00445	46.08676	1.974633	0.0495
IP	1.193065	3.094348	0.385563	0.7002
CA	2.275768	8.167853	0.278625	0.7808
RT	8.017018	5.264662	1.522798	0.0292
GUF	13.19651	8.470644	1.557912	0.1207
LFE	5.975543	3.598142	1.493752	0.1148

G	13.71183	3.768836	3.638214	0.0003
AR01	2.940499	4.307727	0.682610	0.4956
C01	-33.13823	17.60491	-1.882328	0.0611

R-squared	0.058612	Mean dependent var	126.8686
Adjusted R-squared	0.028929	S.D. dependent var	64.09741
S.E. of regression	63.16347	Akaike info criterion	11.16349
Sum squared resid	885696.6	Schwarz criterion	11.28308
Log likelihood	-1275.802	Hannan-Quinn criter.	11.21173
F-statistic	1.974584	Durbin-Watson stat	1.548220
Prob(F-statistic)	0.059613		

Dependent Variable: CDI__CEI_
Method: Panel Least Squares
Date: 09/19/16 Time: 14:51
Sample: 2002 2005
Periods included: 4
Cross-sections included: 63
Total panel (unbalanced) observations: 230
White cross-section standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.542123	0.080693	6.718308	0.0000
EO_SCORE	0.026055	0.019165	1.359515	0.0754
GUF	0.046866	0.050757	0.923344	0.3568
G	0.001678	0.014151	0.118553	0.9057
AR01	0.045258	0.034536	1.310468	0.1914
C01	-0.165078	0.063661	-2.593082	0.0101

R-squared	0.133132	Mean dependent var	0.471103
Adjusted R-squared	0.113783	S.D. dependent var	0.225910
S.E. of regression	0.212669	Akaike info criterion	-0.232416
Sum squared resid	10.13112	Schwarz criterion	-0.142727
Log likelihood	32.72790	Hannan-Quinn criter.	-0.196238
F-statistic	6.880319	Durbin-Watson stat	2.031185
Prob(F-statistic)	0.000005		

Dependent Variable: CYI
Method: ML - Binary Probit (Quadratic hill climbing)
Date: 09/28/16 Time: 16:19
Sample: 2002 2005

Included observations: 230
Convergence achieved after 5 iterations
QML (Huber/White) standard errors & covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-1.936819	0.657155	-2.947279	0.0032
EO_SCORE	-0.117331	0.156599	-0.749245	0.4537
GUF	0.255035	0.491710	0.518671	0.6040
G	0.393371	0.333472	1.179624	0.2381
AR01	0.126994	0.307803	0.412582	0.6799
C01	0.927919	0.275316	3.370381	0.0008

McFadden R-squared	0.158411	Mean dependent var	0.113043
S.D. dependent var	0.317337	S.E. of regression	0.302988
Akaike info criterion	0.646052	Sum squared resid	20.56354
Schwarz criterion	0.735741	Log likelihood	-68.29598
Hannan-Quinn criter.	0.682231	Deviance	136.5920
Restr. deviance	162.3025	Restr. log likelihood	-81.15125
LR statistic	25.71054	Avg. log likelihood	-0.296939
Prob(LR statistic)	0.000102		

Obs with Dep=0	204	Total obs	230
Obs with Dep=1	26		

Dependent Variable: CYI
Method: ML - Binary Logit (Quadratic hill climbing)
Date: 09/28/16 Time: 16:24
Sample: 2002 2005
Included observations: 230
Convergence achieved after 6 iterations
QML (Huber/White) standard errors & covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-3.645556	1.329798	-2.741435	0.0061
EO_SCORE	-0.191025	0.286816	-0.666020	0.5054
GUF	0.500845	1.203758	0.416068	0.6774
G	0.811219	0.736089	1.102067	0.2704
AR01	0.179217	0.558266	0.321024	0.7482
C01	1.772891	0.573122	3.093394	0.0020

McFadden R-squared	0.157237	Mean dependent var	0.113043
S.D. dependent var	0.317337	S.E. of regression	0.303023
Akaike info criterion	0.646881	Sum squared resid	20.56830
Schwarz criterion	0.736570	Log likelihood	-68.39129

Hannan-Quinn criter.	0.683059	Deviance	136.7826
Restr. deviance	162.3025	Restr. log likelihood	-81.15125
LR statistic	25.51993	Avg. log likelihood	-0.297353
Prob(LR statistic)	0.000111		
Obs with Dep=0	204	Total obs	230
Obs with Dep=1	26		

Dependent Variable: LFI
Method: Panel Least Squares
Date: 09/19/16 Time: 14:43
Sample: 2002 2005
Periods included: 4
Cross-sections included: 63
Total panel (unbalanced) observations: 230

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.923303	0.064785	91.43065	0.0000
EO_SCORE	0.016540	0.008168	2.024913	0.0440
CPWRI	-0.000292	0.000321	-0.908522	0.0646

R-squared	0.006299	Mean dependent var	5.904768
Adjusted R-squared	-0.002456	S.D. dependent var	0.253859
S.E. of regression	0.254171	Akaike info criterion	0.111339
Sum squared resid	14.66486	Schwarz criterion	0.156184
Log likelihood	-9.803986	Hannan-Quinn criter.	0.129428
F-statistic	0.719437	Durbin-Watson stat	1.544339
Prob(F-statistic)	0.488133		

Dependent Variable: LFI
Method: Panel Least Squares
Date: 09/19/16 Time: 14:44
Sample: 2002 2005
Periods included: 4
Cross-sections included: 63
Total panel (unbalanced) observations: 230

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.888808	0.042904	137.2553	0.0000
EO_SCORE	0.008768	0.008078	1.085452	0.0789
CDI__CEI_	0.087172	0.086991	1.002082	0.0174
CYI	0.038536	0.075128	0.512942	0.6085

R-squared	0.007621	Mean dependent var	5.904768
Adjusted R-squared	-0.005552	S.D. dependent var	0.253859
S.E. of regression	0.254563	Akaike info criterion	0.118703
Sum squared resid	14.64535	Schwarz criterion	0.178496
Log likelihood	-9.650876	Hannan-Quinn criter.	0.142822
F-statistic	0.578513	Durbin-Watson stat	1.551035
Prob(F-statistic)	0.629683		

Appendix 4: Results of Entrepreneurial Orientation Survey on Management Style

Level of Entrepreneurial Orientation.							
	Item measures						
Participants #	*HIP8*	*HIP9*	*HCA10*	*HCA11*	*HRT12*	*HRT13*	*HRT14*
1	5	3	5	3	5	5	4
2	4	2	4	4	3	3	4
3	3	5	4	4	4	3	3
5	3	2	3	3	2	3	3
6	5	3	4	4	2	4	4
7	3	2	3	3	2	3	3
8	4	2	5	3	3	3	3
9	5	4	4	4	4	4	4
10	3	3	4	4	4	5	4
11	3	3	4	3	3	3	4
12	2	2	5	5	3	5	3
13	2	3	6	5	3	3	5
14	5	5	5	5	5	5	5
15	3	2	4	4	2	3	3
16	4	5	5	5	5	3	5
18	3	2	3	3	2	3	3
20	3	2	3	3	2	3	3
22	4	2	5	2	3	3	3
23					2	2	2
26	5	4	4	4	4	4	4
29	5	5	5		5	5	5
31	4	3	4	3	3	3	2
34	4	2					
35	4	3	3	3	4	5	4
36	3	3	2	4	4	3	3
38	5	3	3	3	3	3	2
17	2	2	3	2	3	3	2
40	5	5	3	3	3	3	3
41	3	2	3	3	3	3	3
3005	3	3	3	2	4	4	4
3003	3	3	3	3	5	3	3
3006	3	2	3	2	3	3	3
3047	5	3	4	4	5	4	4
3031	5	2	3	2	2	3	4
3032	4	5	5	5	5	4	3

3017	4	2	5	5	3	3	2
3001	3	5	4	2	3	3	4
3009	3	3	3	4	4	3	3
3057	3	3	3	5	2	2	3
3020	5	4	3	2	3	4	5
3025	3	3	5	4	4	3	3
3036	3	3	3	3	3	2	2
3052	3	2	3	3	4	4	4
3034	4	2	3	3	3	3	4
3014	5	4	4	4	5	3	4
3023	2	2	2	2	2	2	2
3049	3	4	3	5	3	2	4
3051	3	2	3	4	3	3	3
3051	4	3	4	3	5	4	4
3053		5	4		5	4	3
3002	3	3	5	3	2	3	4
3024	4	4	3	3	2	2	2
3062	3	3	2	4	4	3	4
3054	5	4	4	4	4	4	4
3008	4	3	4	3	3	2	2
3033	5	4	4	4	5	3	4
3035	4	3	3	4		3	3
3018	3	3	5	5	3	2	2
3004	2	3	6	3	2	3	3
3015	5	4	3	3	5	3	3
3016	5	4	5	5	3	4	4
3012	3	2	3	3	2	3	3
3027	4	4	3	4	5	4	5
3041	3	3	3	2	3	2	3
3040	6	5	5	4	4	5	5
3036	3	3	4	3	3	2	3
3005	2	2	2	2	2	2	3